Western Engineering

VOL. 1 SAN FRANCISCO, JULY, 1912 NO. 4

PUBLISHED MONTHLY BY THE WESTERN ENGINEERING PUBLISHING CO. AT 420 MARKET STREET, SAN FRANCISCO.

Entered as second-class matter, June 1, 1912, at the post-office at San Francisco, California, under Act of March 3, 1879

Telephone Kearny 4777. Cable Address; Pertusola. Code: Bedford McNeill (2 editions).

BRANCH OFFICES:

CHICAGO—734 Monadnock Building. NEW YORK—29 Broadway.
LONDON—The Mining Magazine, 819 Salisbury House, E.C.

ANNUAL SUBSCRIPTION:

United States and Possessions, and Mexico..... $3
Canada 4
Other Countries in Postal Union..... 5

CHARLES T. HUTCHINSON - - Editor L. A. GREENE - - Business Manager

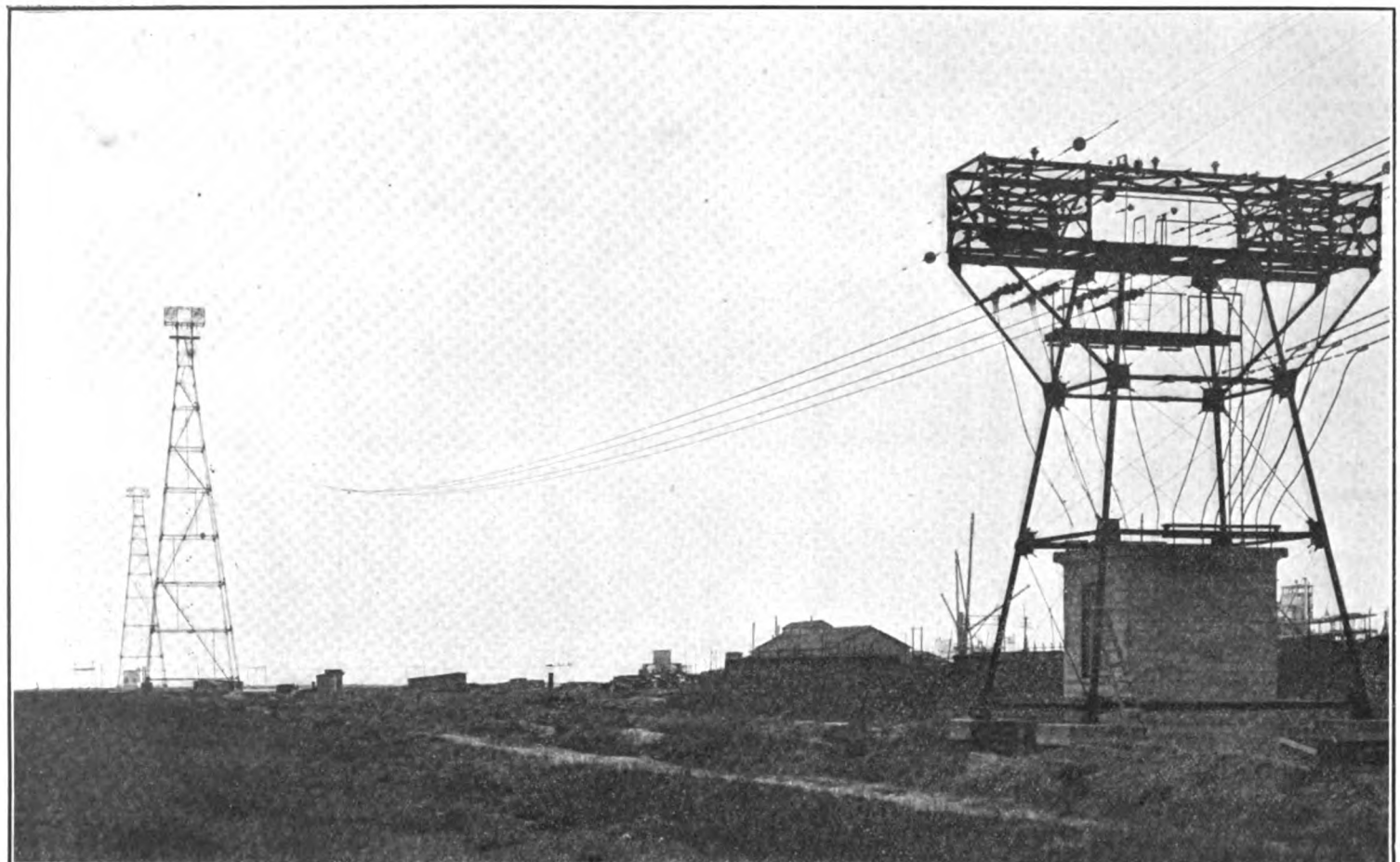
TABLE OF CONTENTS

EDITORIAL: Page.
Notes 254
Canadian Railways 256
Water Power in Great Britain..... 258
REVIEW OF THE MONTH 259
ARTICLES:
The San Antonio Estuary Overhead Electric Cable.....*A. H. Babcock* 263
Modern Highways.....*Austin B. Fletcher* 273
San Diego Water-Supply System.....*M. M. O'Shaughnessy* 279
Swamp and Overflow Lands in California.....*Myron H. Peck* 287
Collapsing Pressure of Steel Tubes.....*R. S. Haseltine* 295
Speed of Water-Wheel Runners.....*Ely C. Hutchinson* 298
Extinguishing a Burning Gusher.....*E. A. Flanders* 300
ENGINEERING DIGEST:
The Fuel Economizer.....*T. F. J. Maguire* 302
Tons of Stone Per Mile Required to Build Roads..... 307
Egyptian Drainage Project.....*D. R. Birch* 309
Observations on the Disintegration of Cinder Concrete.....*George Borrowman* 311
Variable Speed Drive..... 312
The Diesel Engine.....*Rudolph Diesel* 314
Concrete Roads of Wayne County, Michigan.....*George A. Dingman* 317
Developing Water Power in the Western States..... 321
BOOK REVIEWS 325
ENGINEERING BONDS 326
COMPANY REPORTS 327
ENGINEERS' NOTE BOOK 328
ENGINEERING NEWS 329
MARKETS 334
INDUSTRIAL PROGRESS:
Fundamentals of Good Roads.....*P. W. Rochester* 335
Cutting Pavement With Pneumatic Machines.....*A. S. E. Beall* 337
CATALOGUES RECEIVED, PERSONAL, COMMERCIAL PARAGRAPHS.... 338

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google



OVERHEAD CABLE TRANSMISSION OF THE SOUTHERN PACIFIC RAILROAD COMPANY AT THE SAN ANTONIO ESTUARY. (See p. 263.)

Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

EDITORIAL

DISSOLUTION of the so-called Powder Trust has been ordered by the United States Circuit Court at Wilmington, Delaware, the final decree having been entered on June 14. It is said to be impossible to unscramble eggs, and the question naturally arises whether it would be not only difficult but dangerous to attempt to do the same thing with powder.

CANALS have been known even to add to the prosperity of their builders. This is particularly true of the Suez canal, which paid dividends last year of £1,129,260 to the British Government. Lord Beaconsfield bought the shares in this enterprise thirty-five years ago for political reasons. The purchase price was £4,000,000, on which dividends have been paid aggregating £17,000,000.

ILLUSTRATION of a typical rotary drilling rig used in *Western Engineering* for June has been criticized as not showing the most convenient arrangement. It was reproduced from a bulletin of the United States Geological Survey made some time ago, since when methods have been improved in many particulars. The settling ditch should extend around the engine-house, to surround one-half of the rig instead of three-quarters. The casing rack in the illustration is opposite the engine, which would interfere with cleaning the ditch if extended around that point. The settling ditch should run in a direction opposite to that shown in the illustration.

UNCONVENTIONALITY is considered to be one of San Francisco's chief charms by visitors from the East. If the plans of the diligent promoters of festivities for 1915 are carried out, however, conventions will be the order of the day. Conditions seem favorable for the holding of a great engineering congress during the fair, and the National Electric Light Association has been invited by Mr. John A. Britton, on behalf of the Exposition directors, to hold its 1915 meeting in San Francisco.

TWIN PEAKS reservoir is once more in the limelight, this time on account of a matter more serious than dedicatory exercises. Serious leaks developed in the expansion joints at the bottom as soon as water was turned in. The usual controversy at once ensued between the contractor and engineers as to the fixing of responsibility for the trouble. The Mayor appointed Messrs. M. M. O'Shaughnessy, W. R. Eckart, and Howard C. Holmes to examine into the merits of the case, and these gentlemen have made a preliminary report criticizing both engineers and contractors for imperfect construction and design. Minor defects nearly always develop in engineering work of any magnitude when subject to test. That is what tests are for. If engineering design and construction were an exact science, engineering as a profession would cease to exist. Certain fundamentals and precedents exist, and these, in a general way, are applicable to the piece of engineering work under consideration. It is in the reduction

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

of these fundamentals and precedents to suit a specific case that true professional skill is brought to bear. The exceptions to rule are voluminous, the rules themselves are comparatively few. That differences of opinion frequently exist among experts is shown time and again in court testimony. It would be well for engineers to suspend judgment until the full text of the report by the Mayor's committee has been published. The high professional standing of the men selected gives assurance that the report will be just, conclusive, and a true presentation of the facts.

CALIFORNIA'S system of state highways is under actual construction. Contracts aggregating $295,000 were let June 25 by the Highway Commission at Sacramento. The sections to be built are in Madera, San Mateo, Mendocino, and Yuba counties, the length of the four strips aggregating 37 miles. The engineering department of the Commission is giving due consideration, in the preparation of specifications, to the volume of traffic which each section of road will have to withstand. The 5.4-mile section in San Mateo county will cost $89,368, the 9-mile section in Yuba county $67,780, the 10-mile section in Madera county $72,091, and the 13-mile section in Mendocino county $67,425. The heavy motor traffic to and from San Francisco necessitates the highest type of road construction. Concrete is to be used for foundations, ordinary macadam, or so-called 'bituminous' concrete being incapable of resisting the destructive action of motor cars.

IN YEARS gone by, San Diego's jealous neighbor, Los Angeles, sought to ma[illegible] San Diego's water misfortunes [illegible] intending visitors to San Diego demijohns of water to tide them over their trip, with the statement that San Diego had no water. San Diego can now return the compliment by sending demijohns of pure water back to Los Angeles, as San Diego's water is of a clearly superior quality for drinking and domestic uses, there being an entire absence of typhoid in the city of San Diego. The city now has an option to purchase this property for $4,000,000, and the proposal will be submitted to the voters next August, when they will decide whether the city shall take over this system. The present contract price of water, 4 cents per 1000 gallons, is merely a temporary rate which will expire in a few years, and if the city does not take over the system the company will expect to get at least 10 cents a thousand gallons in order to return an adequate compensation on the investment.

Canadian Railways

TRANSPORTATION facilities in the United States have reached a state of development so advanced that Americans scarcely realize the strides that have been made by our neighbor on the north. Canada is preparing to claim its share of the world's trade confidently expected to flow westward with the opening of the Panama canal. Remarkable progress is being made in railroad building, the present and projected mileage aggregating a total that shows commendable enterprise on the part of the empire builders of the north.

There are now over 8000 miles of railway in the western provinces, the new construction during the last five years totaling 2000 miles. The increase in total mileage for the Dominion for 1907 was 28 per cent; for 1908, 29; for 1909, 30; for 1910, 31; for 1911 over 32.

Generated on 2024-09-29 23:50 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

It is announced that within two or three years the Grand Trunk Pacific and Canadian Northern roads will be operating from ocean to ocean. The main line of the Canadian Northern now runs from the head of the Lakes to a point 200 miles beyond Edmonton, and contracts have been let for construction across the mountains to Vancouver. In British Columbia 500 miles are under construction from Vancouver to the Yellowhead pass, which will be completed by the end of 1913. When the work on the main line between Sudbury and Port Arthur has been finished, the company will have a through road from the Pacific Ocean to Quebec, and a connection to the Atlantic by the Intercolonial Railway system. The main line of the Grand Trunk Pacific has been extended over the Rocky Mountains to a point nearly 1200 miles west of Winnipeg. It is expected that contractors now engaged in working eastward from Prince Rupert will effect a junction within two years. Two hundred and thirty miles only remain uncompleted on the National Transcontinental section, which runs 1800 miles across northern Quebec, between Moncton and Winnipeg. The Grand Trunk system has obtained rights to run over the government-owned Temiskaming & Northern Ontario railway from its junction with the National Transcontinental railway to North Bay, where connection will be made with the Grand Trunk system in eastern Canada.

Three great transcontinental systems are furnishing keen competition for traffic in the western provinces. During the last few months the British Columbia legislature has guaranteed bonds for railway building to the amount of $45,000,000, the Alberta legislature for $35,000,000, and the Saskatchewan legislature for $25,000,000. The country west of Lake Superior now has 4200 miles of railway under charter. Complaint has been made by the people in the territory served that the rolling stock has not increased in proportion to the track extension. This condition will be remedied as rapidly as circumstances permit, however, and there is no doubt that development in the Canadian west will make great strides during the next few years. While the history of Government aid to the builders of the Pacific railroads in the United States is still fresh in our minds, it is worthy of note that the Canadian Government does not hesitate to back the railroad-building enterprises of its people. The National Transcontinental railway will cost about $250,000,000. It is government-built and government-owned, but not government-operated, being rented by the Grand Trunk company. In addition to a bond guarantee of 75 per cent of the cost of the western sections of the Grand Trunk Pacific railway, the road will be assisted with money subsidies amounting to $20,000,000.

In federal and provincial guarantees, cash subsidies, and land grants, the Canadian Northern railway will receive between $200,000,000 and $250,000,000 of government backing. In the light of these facts we cannot but wonder what would be the political fate of the luckless member of Congress who would introduce a measure for the financial assistance of an American railroad. Political lines are sharply drawn in Canada also, as is shown by the effective quietus put upon the proposed reciprocity measure. All has not been plain sailing for the builders of the Government-subsidized railroad, as vigorous criticism has been made of the cost and methods of construction. As the people must bear the cost of building and the

Generated on 2024-09-29 23:41 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

interest charges until 1924, their interest in such details is not unnatural. The contract with the Grand Trunk company calls for their portion of the interest charges to be 3 per cent of the total cost of the road. This amounts to $7,500,000 annually, and adding the interest on $500,000 of rolling stock, makes a total charge of nearly $8,000,000. This charge, distributed over only 1800 miles of road, does not compare favorably with $5,400,000 on 3000 miles of road in the older portion of Canada. The National Transcontinental section must earn at least $11,000 per mile in a sparsely settled territory, while the earnings of the Grand Trunk system, through the more thickly settled territory, are but $10,600.

It is not to be expected that the new development, rapid though it may be, will produce such earnings as these. The Government will undoubtedly be called upon to modify its terms, until such time as the pioneer stage in development has passed. In the meantime, settlers will flow in, attracted by the wonderful natural resources of the territory. Industrial enterprises of all sorts will follow, and western Canada is on the eve of a development that augurs well for a great and prosperous future.

Water-Power in Great Britain

GREAT BRITAIN is so famous as the coal-producing country of the world that its possibilities as a field for the development of water-power have received scant consideration. According to Mr. Alexander Newlands, there are three hydro-electric power-generating plants in Great Britain, two of which are in Scotland, at Foyers and Kinlochleven, respectively, and which belong to the British Illuminating Company. The third is at Snowdon, Wales, and generates power for use in the slate quarries. A project was proposed some time ago for the utilization of the large mountain lakes east of Snowdon, but thus far nothing seems to have been done. The mountains of Derbyshire and Yorkshire provide extensive catchment basins which are at present used for conserving water supply for the neighboring towns. Mr. Newlands calls attention to the fact that the north and west of Scotland have a greater extent of elevated area than any other part of Great Britain, which, together with a rainfall that is fairly uniform throughout the year, would indicate the existence of hydro-electric power generation possibilities. There are also many mountain lakes, the discharge of which to the seaboard is steep and rapid. There are no glaciers or exceptional spring floods from melting snow. The rainfall in many places is over 60 inches per year, and 42 inches is taken as a safe figure to cover the entire region. Mr. Newlands has mapped various districts where the rainfall and catchment basins can be accurately estimated, and states that the largest of these has a potential horse-power of 20,000, the total aggregating nearly 200,000 horse-power. These figures are exclusive of Kinlochleven, rated at 30,000 horse-power, or Foyers with 7000 horse-power. The drainage area at Kinlochleven is 55 square miles, and the water is impounded by a dam 4000 feet long with a maximum height of 86 feet, the overflow sill being 1065 feet above sea-level. The average yearly rainfall is 70 inches, for which storage is provided by a reservoir 7½ miles long, ½ mile wide, having a capacity of 20,000,000,000 gallons. The northern part of Scotland undoubtedly has many possibilities.

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

REVIEW OF THE MONTH

POLITICS has occupied the centre of the stage during the month to the exclusion of all other matters. Many distinguished Americans seem anxious to leave their regular pursuits and come to the rescue of their country. The 'common' people have suddenly become potent; their votes may make or unmake a president. The most skilful constructors of platforms are vieing with one another in the effort to turn out a declaration of principles that will stir the cautious calculating voter to the right pitch of enthusiasm and will bring votes to their candidate.

FATE of the platform after election has become, by common consent, a matter of less interest, the present political crisis thus far seeming to be a contest between men rather than pre-election declarations of principles. The majority of votes will be cast for the candidate whom the great mass of the people believe is to be trusted to represent their interests and carry into effect the measures that will make for the utmost development of the country. Engineers as a class may view the situation from any standpoint that suits their personal opinions and comfort themselves with the assurance that without that product of their genius, the steam-roller, the political convention of today could not exist.

STEAM-ROLLERS seem to be capable of a variety of applications, however, and Congress has one of its own that is in fair working order. The Commerce Court has suffered at its hands, Congress having voted to abolish it June 11. Whether the President will acquiesce is as yet unknown. Opinions differ as to the function of the court, and there was a widely prevalent view that its creation was for the purpose of nullifying, as far as possible, the acts of the Interstate Commerce Commission. There is more than a hint that the Court itself took this view, certainly it took itself seriously enough —too seriously, in the opinion of the United States Supreme Court. The Commission has proved beneficial to shippers and railroads alike, and its good work should continue without interruption; a Commerce Court to decide legal points only, might be a useful institution, but there is no need for one that proposes to review matters of fact as well.

SACRAMENTO does not feel that it can afford to let another year go by without taking steps for controlling the floods that do damage amounting to thousands of dollars annually. Mr. George N. Randle, city engineer, has submitted a plan to the trustees providing for the application of the 'by-pass' method, originally advocated by Mr. C. E. Grunsky and his associates, an outline of which has been published in the April *Western Engineering*. The plan recommended by the California Débris Commission was elaborate and comprehensive, calling for an expenditure of $33,000,000. The plan proposed by Mr. Randle is much simpler and provides for the protection of the city of Sacramento only. The vast irrigation projects north of the city add greatly to the danger of inundation. A

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

bond election is to be held in July to authorize an issue of $887,000. We hope the project may be ratified and work inaugurated without delay.

PREPARATION for the increase in ocean traffic that will come with the opening of the Panama canal goes steadily on. The American-Hawaiian Steamship Company has five freighters under construction at Sparrows Point, Maryland. They are to cost $700,000 each. The first will be launched within a few months, and as soon as all have been completed, three more are to be built. W. R. Grace & Company is also making extensive preparations for a record increase in business. Nine large vessels in all are being built, five in America and four in England. These vessels will engage in freight and passenger traffic in the Atlantic and Pacific South American trade, where the company is already operating a fleet of about twenty vessels. In the meantime the company has fitted the Norwegian vessels now in freight service for passenger traffic, and the boats now carry through passengers from San Francisco to Peru and Chile. The Oceanic Steamship Company has resumed service to Australia and New Zealand, the Postmaster General having accepted its proposal for carrying mails. This company has not operated vessels beyond Tahiti since 1907, and it is to be hoped that the resumption will bring the trade back to the Pacific Coast that has been diverted elsewhere.

THE Pacific Mail Steamship Company still shows a deficit, though not so great as for the year previous. The report for the year ended April 30, 1912, shows total receipts of $5,285,199, as compared with $4,974,819 for the year previous. Expenses for the year past aggregate $4,819,638 and net receipts amount to $443,023 as compared to $155,181. Making deductions for depreciation and repairs, a deficit is shown of $19,082, as compared to $199,-276. As a matter of fact, the company did an excellent business this past year. It has even been necessary at times to charter extra boats to carry surplus freight. The fundamental reason that the company's accounts show a continued deficit is the fact that it does not own the larger steamers that are operated under its flag. The *Manchuria, Mongolia, Korea*, and *Siberia* were bought, not by the Pacific Mail, but by E. H. Harriman personally, or some one of the Harriman railroad companies. Ownership is said to now lie in the Harriman estate. The boats are leased to the steamship company, which latter assumes all operating charges and insurance. It has been stated that on one of the boats costing $2,500,000 the rental is $1000 per day. Evidently, if the Pacific Mail had borrowed the money to build this boat, in place of chartering it, the accounts would tell another story. As a matter of fact, the Pacific Mail boats, with Chinese crews and American officers, are operated with remarkable economy, and with proper reorganization on shore the company has little to fear from competition, Oriental or otherwise. The Pacific Mail, the historical steamship company of the West, has made mistakes in the past and has its share of unpopularity to live down, but fundamentally the business is sound.

STEAMSHIPS are not the only means of transportation that are responding to the impetus given by the prospective opening of the Panama canal. The Canadian Pacific railway is preparing for a great increase in trade.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

No less than 10,000 new freight cars have been ordered at a cost of $14,000,000, and 300 locomotives at a cost of $3,000,000. San Francisco's new docks are being rapidly prepared. Contracts were let on June 27 to the San Francisco Bridge Company for the construction of Pier 28, for the sum of $358,000. The new pier will be supported on concrete cylinders and will be 800 feet long and 150 feet wide. Two railroad tracks connecting with the belt railroad are to be provided. The shed will be made of reinforced concrete and will be 113 feet wide and 780 feet long. This pier will be assigned to the Matson Navigation Company when completed. Three others are already under construction which when completed will constitute the finest piers ever constructed on the Pacific Coast. Wireless telegraphy is so inseparably connected with modern steamship operation that it is not surprising that it, too, has been progressing by leaps and bounds. The laboratory toy of a few years ago has become an indispensable adjunct to modern life. The Marconi company has announced its intention to erect twin stations on the coast of New Jersey to communicate direct with London. A similar station is to be built in the Philippines for communication direct with Honolulu. Messages will be relayed from that point to the Pacific Coast, and it seems but a short distance into the future when the wireless telegraph will encircle the globe.

INCREASE in the production of portland cement for 1911 was only about a million and a half barrels, according to the United States Geological Survey. This is the smallest increase on record for 13 years, and indicates not only that trade conditions have been unsatisfactory, but that people generally do not appreciate the many uses to which cement may be applied advantageously. In certain types of engineering construction it fills a place of its own for which there is no substitute. Its value as a foundation for good roads, however, is only beginning to be appreciated, and in the preparation of specifications road-builders are commencing to consider cost of maintenance as well as first cost. The total production for 1911 was nearly 80,000,000 barrels, of which it is interesting to note that California ranks third among the states, having produced 6,317,701 barrels, which is exceeded only by Pennsylvania with 26,864,679 barrels and Indiana with 7,407,830 barrels. California has eight producing plants and Washington three, the total production on the Pacific coast being 7,278,274 barrels, or about 9 per cent of the whole. While the increased percentage of gross production for 1911 was 2.29, a decrease of 1.48 per cent in value has taken place. The average price per barrel at the factory for the Pacific coast for 1911 was $1.406, which is the highest price in the United States. Prices decrease toward the East, the prices in the Rocky Mountain district averaging $1.186, in Illinois and Indiana $0.791, and in New Jersey $0.715.

RAILWAY wages enter into the cost of living and the latter vitally affects the welfare of everyone. The Board of Railway Economics has just completed the second of its comparative studies of railway conditions in the United States and the principal countries of Europe, and presents an interesting comparison of conditions as they exist here and in Europe.

A recent report of the English Board of Trade on railway wages shows that the average weekly pay of enginemen in the United Kingdom in 1907 was

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

$11.17; of firemen, $6.67. In the same year enginemen on American railways received an average weekly compensation of $25.80, counting six days to the week, and firemen $15.24. Recent returns make it clear that in 1912 enginemen and firemen in the United States are compensated at rates of pay for specific runs that are two, three, and four times as high as the corresponding rates on representative English railways. The annual compensation of enginemen in the United States, as reported by two representative railway companies, now ranges from $1100 in switching service to over $2800 in passenger service, and of firemen from $700 in switching service to over $1700 in passenger service. For Continental Europe official returns in requisite detail are not available for a later year than 1908. The salaries and allowances of the typical engineman in Germany amounted for that year to $646.88, in Austria to $870.80; of a fireman in Germany to $424.59, in Austria $532.03. The annual compensation of enginemen on two of the principal railways of France ranged in 1908 from $505.66 to $906.91, and of firemen from $324.24 to $595.98. In Italy enginemen received in 1908, salary and allowances included, from $581.10 to $812.70 per year; firemen, from $330.30 to $475.05 per year. In these Continental countries the maximum compensation is received only after many years of service. In Belgium enginemen received in 1907 from $23.16 to $38.60 per month; firemen, from $17.37 to $23.16 per month; conductors and station employees, from 46 to 96c. per day. In the United States, in the same year, 1907, enginemen averaged, on the basis of 25 days' service, $107.50 per month; firemen, $63.50 per month; conductors, $3.69 per day; while station employees averaged from $1.78 to $2.05 per day.

The average annual compensation of enginemen in the United States in 1908, on an estimated basis of 300 days' service, was $1335; of firemen, $792. In this country the rate of compensation to these employees does not depend on length of service.

The average daily compensation of railway employees of all classes for the year 1910 was in the United States, $2.23; in the United Kingdom, $1.05; excluding supplementary allowances negligibly affecting the average, it was in Prussia-Hesse 81c., and in Austria 89c. The lowest paid railway employee in the United States, the ordinary trackman, receives a greater compensation than many of the railway employees of France, even those of higher grades and with responsible duties. The compensation of railway employees is from two to three times as high in the United States as in Italy.

The rental of a three or four room house or flat is almost as high in Berlin, Paris, or London as throughout the United States, but in England and on the Continent it generally runs from $30 to $90 a year less. The quantity of food and fuel estimated by the Board of Trade of England as the standard consumption of a typical workingman's family costs in the United States 17.8 per cent more than in France or in Germany; 35.3 per cent more than in Belgium, and 38 per cent more than in the United Kingdom. It is well within the truth to estimate in a broad and general way that while the cost of living of a railway employee in the United States is less than 50 per cent higher than that of a corresponding employee in the United Kingdom or on the Continent, his compensation averages over twice as much.

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The San Antonio Estuary Overhead Electric Cable

By A. H. BABCOCK*

SAN ANTONIO ESTUARY is an arm of San Francisco bay lying between the Alameda mole and the north training wall, and is approximately 1000 ft. wide at the point selected for the overhead electric cable crossing for the Southern Pacific Company's electric suburban train service. So many questions have been asked concerning the reasons for the selection of an overhead crossing in preference to a submarine cable that a brief statement will be made of the operating conditions that determined the selection.

Fig. 1 shows the Southern Pacific Co.'s electrified lines in Oakland, its steam railway, and its high-tension overhead and underground transmission lines in this part of the bay district. The project as shown is practically that now under operation, and covers at present approximately 120 miles of single track, although nearly all of the lines are now under double-track operation. The power-distributing lines may be divided into two classes, namely, 13,200-volt alternating current, 3-phase, 25-cycle lines, and 1200-volt continuous current lines.

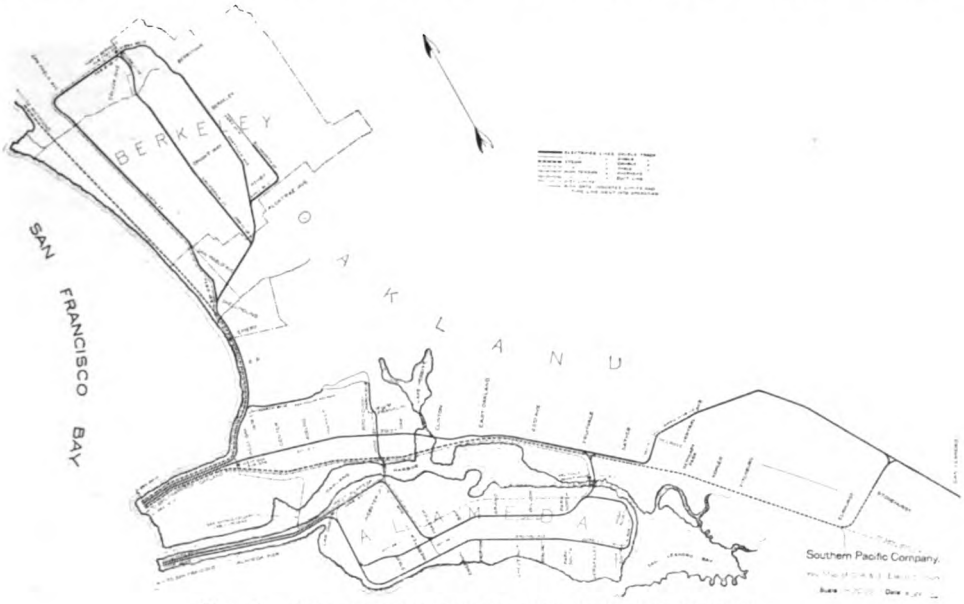


FIG. 1. MAP OF SOUTHERN PACIFIC SUBURBAN SYSTEM.

The power station is at Fruitvale, and contains, in addition to the turbo-

*Electrical Engineer, Southern Pacific Company.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

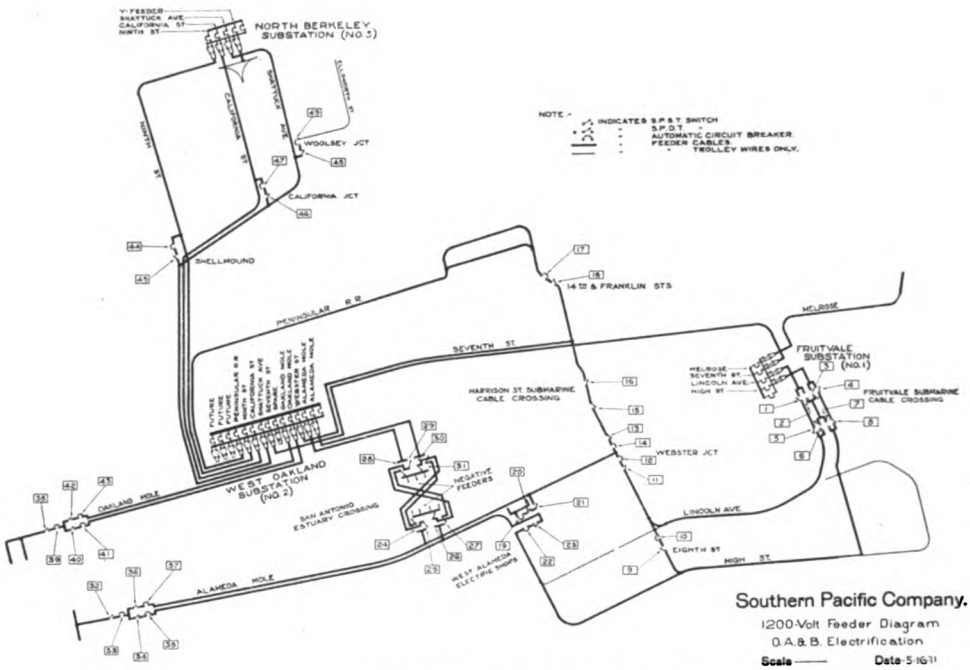


FIG. 2. 1200-VOLT FEEDER DIAGRAM.

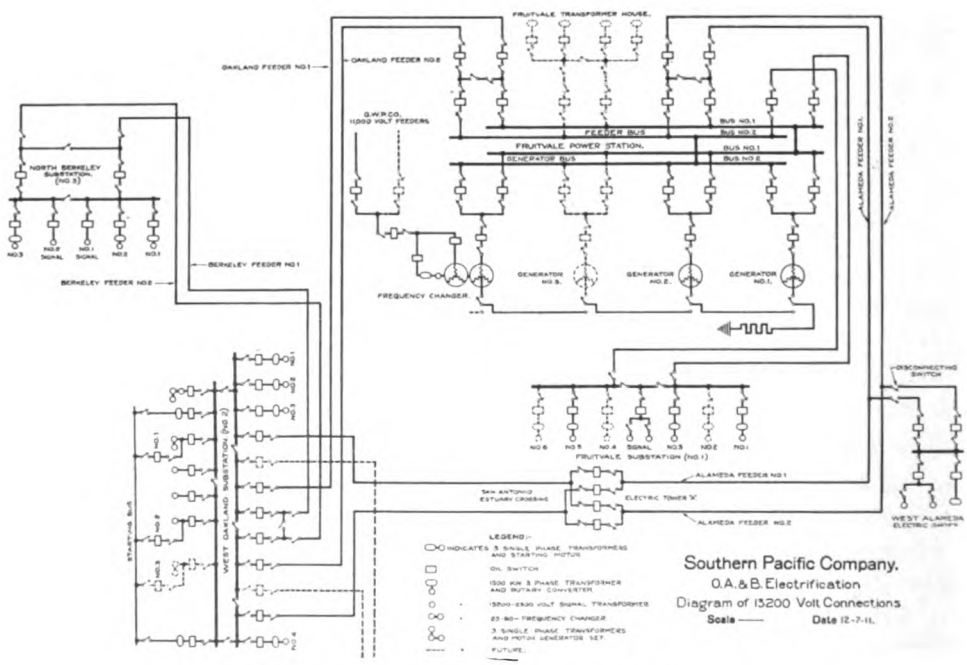


FIG. 3. DIAGRAM OF 13,200-VOLT CONNECTIONS.

Generated on 2024-09-29 23:48 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

generators for converting the energy of fuel oil into electricity, a sub-station that converts the 3-phase alternating current into continuous current for the use of the railway trains. The second sub-station is at West Oakland, near the point where the Oakland mole reaches the mainland. The third sub-station is at North Berkeley.

The geographical position of these three stations is such that West Oakland sub-station naturally becomes the distribution point for all energy northward toward Berkeley, as far as the alternating current is concerned, and also distributes the continuous current for the Oakland mole and the entire district surrounding. It also furnishes continuous current to the Alameda mole line and to practically half of the lines in the city of Alameda. It will be seen, therefore, that continuity of service to and from West Oakland sub-station is a very important element in the successful operation of the system of electrification as a whole. For this reason duplicate transmission lines were run over two geographically separated routes between the Fruitvale power station and West Oakland sub-station. One of these lines passes through Alameda and over the San Antonio estuary crossing, while the other passes through the city of Oakland. Both lines are duplicated, the intention being to have two complete and separate means of supplying energy to West Oakland sub-station from the power-house. On account of the fire hazard through certain districts in Oakland, the Oakland feeder was put underground for a considerable distance. Since a cable not more than 1000 ft. long would have reached under water from the Alameda mole to the Oakland side, the question naturally is asked as to why a submarine connection was not used, rather than an overhead. The reason is that it costs no more to go overhead, and there are very great advantages from a maintenance standpoint in the overhead construction. A submarine cable must be laid beyond the reach of anchors and of dredging, which means that a trench would have to be dredged across the estuary in which the cables would be laid; then tidal action would fill this trench so that the cables really would be lying in mud, which is a very poor heat conductor. None of the cable manufacturing companies would undertake to furnish cables for this purpose unless they were allowed to use rubber as the insulating material. On account of the service they have to perform, these cables must necessarily carry very large currents. Experience with such cables in Eastern waters has shown conclusively that a rapid deterioration of the rubber compound takes place when cables are made to carry heavy current and are imbedded in a heat-insulating material. A failure of one of these cables, then, would mean that it no longer could be used for carrying current that must be insulated from ground. It is true that its useful life could be prolonged by using it on the negative or grounded side of the circuit until such time as the current leaking through the defect in the cable that made it unfit for use with positive current, would cut off the cable at this point. When this time should arrive, the cable would become useless for all purposes and there would be no salvage, because such a cable cannot be pulled out of its bed. Its cost then would represent a total loss that would have to be absorbed over an unknown period of usefulness; but the Eastern experience mentioned above has shown that its life would not be long. For

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

these reasons, and on account of the necessity for a continuous supply of energy to West Oakland sub-station, it was considered best to go overhead, a decision that was more easily reached when detailed estimates were made and it was found that the overhead construction, all things considered, would cost little, if any, more than the submarine construction.

The estuary proper is spanned by two towers, 260 ft. high, one on each side of the estuary, and 1290 ft. apart, with the third tower, 35 ft. high, situated on the West Oakland side, 1331 ft. from the middle tower. The vertex of the crossing span is 200 ft. above mean high water. With the point of attachment 250 ft. above mean high water there is a 50-ft. sag in the 1290-ft. span. The vertex of the land curve is at the north tower, with 215-ft. sag. The clearance in the channel span was fixed by the U. S. War Department, and the arrangement of the land span was dependent upon the layout of buildings and tracks on the company's property on the north side of the estuary.

Four 2,000,000 cir. mil. bare stranded aluminum cables are anchored at north tower, carried to the top of middle tower, suspended there on I-beam trolleys, and at south tower are attached to counterweights through chains that run over four large sheaves at the top of the tower. The counterweights are adjusted to give proper sag of 50 ft. in the channel span with no wind pressure. The variations due to wind pressure and temperature in all of the spans are taken up by the vertical movement of the counterweights; in other words, the cables which are anchored at the north tower are free to move, within certain limits, at the south tower, and consequently the horizontal tensions at all points in the cable are equal. Besides the aluminum cables, there are six No. 00 hard-drawn stranded copper high-tension conductors; that is, there are two 3-phase circuits that carry the alternating current from the power-house to West Oakland sub-station over these towers, and four continuous-current, 1200-volt conductors that carry the energy back from the West Oakland sub-station to the trolley system on Alameda pier, and the West Alameda lines.

The connections between the stationary ends of the aluminum cables at the north tower and the tower structure were easily made by means of special dead-ends designed by the manufacturer of the cable. The details of these connections will be described later. Since these ends are stationary, the connections, both mechanical and electrical, presented no serious difficulty, but the situation at the south tower, where a considerable movement may take place, was entirely different. In following the description to be given of the method of calculation to determine the amount of this motion, it should be remembered that besides the movement at the south tower, the point in the two spans common to both spans at the top of the middle tower (the hangers, cables, etc.) is free to move in a direction parallel with the length of the span in order to take up the variation due to temperature and wind strain and hence to maintain constant horizontal tension in the cable.

Commencing with the fixed ends of the spans at the north tower, the horizontal length of the land span being 1331 ft., the length of the cable therein at normal temperature is 1354.153 ft. At maximum temperature this length becomes 1355.019 ft., corresponding to a horizontal span length

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

of 1331.865 ft.; which means that the hanger at the middle tower was moved to a point that distance from the reference point of the north tower. The channel span, then, will have been shortened to 1289.135 ft. and the length

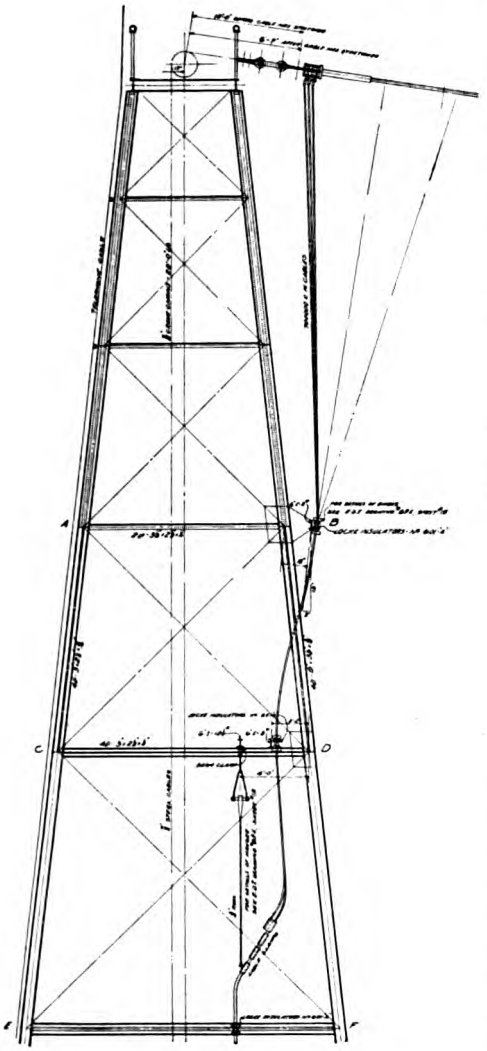


FIG 4. SOUTH TOWER CONNECTIONS.

of the cable in this span will then be 1294.298 ft. Since the length of the cable in the channel span at normal temperature is 1295.16 ft., it follows that the expansion of the cable in the land span has caused 0.878 ft. of cable to pass inboard at the south tower, the channel span still being assumed at normal temperature. When this span is increased in length by expansion due to maximum temperature, 0.829 ft. more of cable will pass inboard, making the total movement at the south tower 1.707 ft. in a southerly direction, at maximum temperature and no wind. This calculation, then, gave the southernmost point of the ends of the cables in both the channel spans at the south tower and in the land span at the middle tower.

Following a similar line of reasoning, but assuming that in the land span the temperature drops to the minimum and that the wind increases from zero to

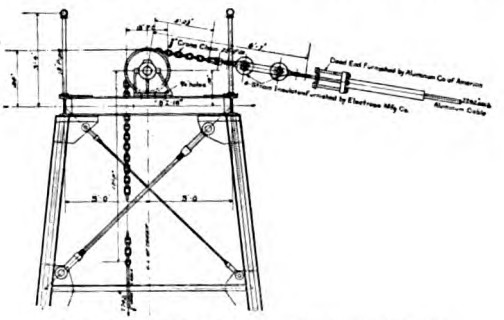


FIG. 5. SHEAVE AND COUNTERWEIGHT ARRANGEMENT.

the maximum assumed, it was found that the south end of the land span would be shifted to a point 3.542 ft. north of the reference point of this tower; consequently, the maximum movement at the middle tower is seen to be 4.407 ft. The horizontal length of the channel span now has increased to 1293.542 ft. To maintain constant tension in the channel span at normal temperature and maximum wind, the length of the cable in this span under these conditions must be 1301.055 ft. Since the normal length of cable in this span is 1295.16 ft., the movement outboard at the south tower due to the wind in both spans and minimum

Generated on 2024-09-29 23:48 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

temperature in the land span, amounts to 5.895 ft. Assuming that the temperature in the channel span drops to the minimum at the same time, 0.829 ft. more will pass over the sheave, which makes a total outboard movement from all causes 6.724 ft., to which 1.707 ft. must be added for maximum inboard movement, as noted previously, and the gross movement from all causes at the south tower then becomes 8.431 ft. While these movements are the maximum that might be expected under the most extraordinary conditions, and a sufficient amount of play was provided in the counterweight attachment, nothing like this movement ever has been observed in practice. As a matter of fact, probably 3 ft. would cover the maximum movement that has been observed under the most extreme conditions of wind and weather yet experienced, but in order to provide for this very large possible movement of the south end of the channel span, a special form of flexible connection had to be devised. To make the mechanical attachments easier than if full-size cable connectors were used at the south tower to run from the moving end of the channel span cables down the tower, the risers to the four large cables were made of three 700,000 cir. mil. cables each. Brackets were fastened to the water side of the south tower at a point about 26 ft. below the centre line of the sheave, to which were secured insulators of the floor bushing type, acting as fair-leaders to the 700,000 cir. mil. risers. The details of these connections are shown in Fig. 4.

The tension in the cables at the south tower is 7742 lb., obviously entirely too great a tension to subject a soft aluminum cable which is to be moved in and out over the sheaves under the conditions named above. Consequently, a dead-end was provided just outside of the tower for attaching the cables to chains that lead over the sheaves. The counterweights move freely, and yet the substance moving over the sheaves may not be affected by wear. From the tower end of this chain a rod leads down to the reinforced concrete weight. Besides the weight itself, there are provided for adjustment slotted discs of cast iron to be slipped on top of the counterweights after the manner of the weights on a platform scale beam. The very ingenious dead-end connections that are used to distribute the strains in the aluminum cable so that every one of the 127 strands of the cables shall sustain its proper proportion of the load, were designed by the manufacturer. For the details of this construction, reference should be made to the illustration (Fig. 6) where it will be seen that the principle is to bend the individual strands over an easy curve into slots grooved in the surface of the curved blocks, and to secure the successive concentric layers of the cable in place by superimposing one block upon another, the outer layer, of course, going on first, the next layer on top of that, so that progressively from the first to the last block there will be six less slots in every block, until finally the centre is reached, where there are only seven slots, as compared with thirty-six at the start. By providing these blocks with suitable lugs, it is

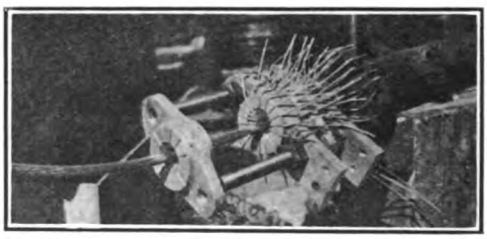


FIG. 6. DEAD-END CONNECTION.

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

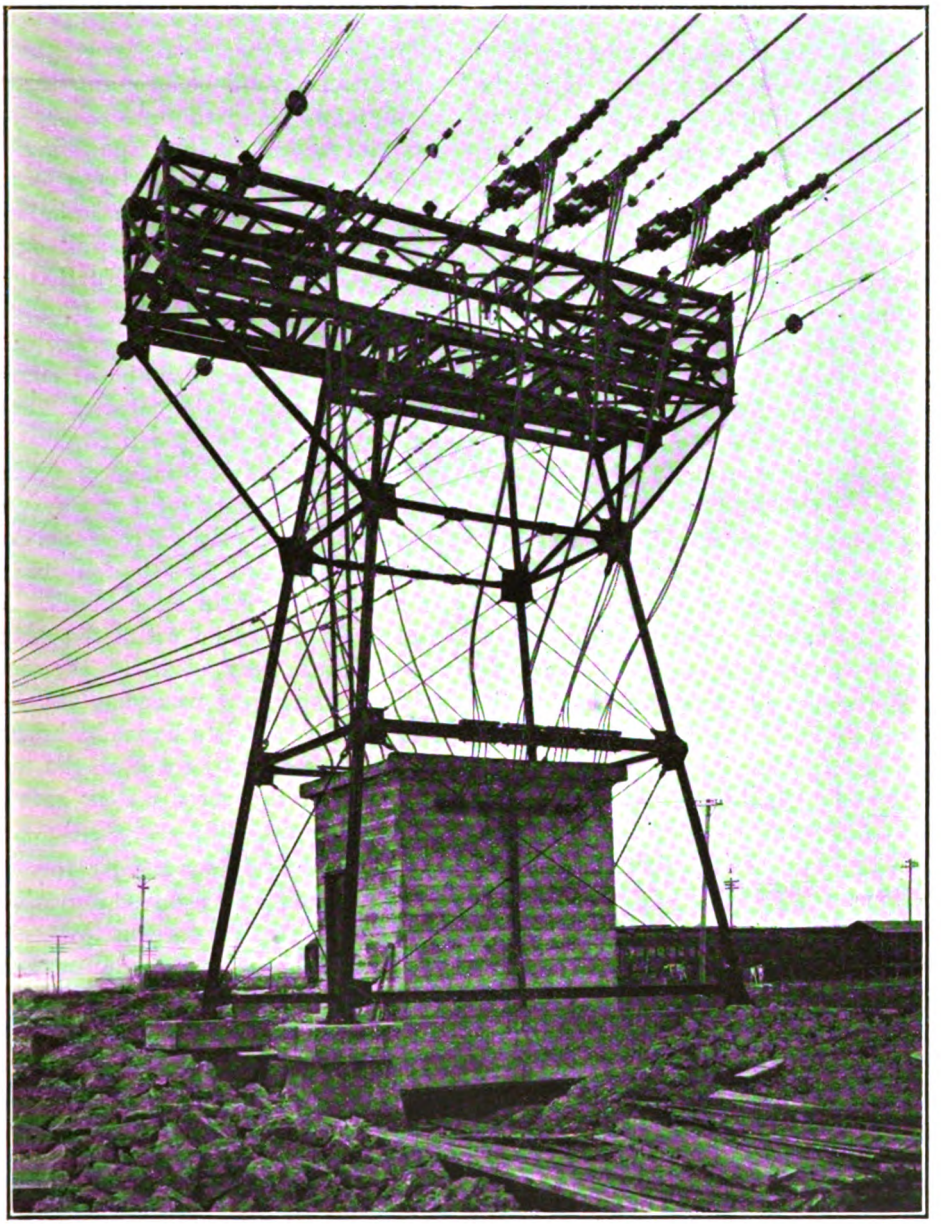


FIG. 7. NORTH TOWER AND SWITCHING CHAMBER.

easy to make the electrical connections from the dead-end down. Insulation is maintained by two spool-type insulators installed at every point of attachment to the tower structure, so that there are always two insulators in series between the live cables and the ground.

At the middle tower, the ends of the land and channel spans, where they meet, are secured by **I** bars through which a pin passes, the pin going also

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

through the centre of the insulator, from which, by a suitable saddle arrangement, is suspended another electrose insulator that is secured to the hook of the trolley. The vertical components of the weights suspended at this point total 3683 lb. per cable, to carry which 3-ton I-beam trolleys of the ordinary type were installed. They run on the top of the bottom flanges of 9-in. I beams. Jumper bars of 3 by 3/16-in. flat aluminum bar were provided at the middle tower to run between the two dead-ends and thus avoid carrying heavy current through the pin connection above mentioned. In the bases of the north and south towers are placed switching chambers, in which bus-bars and oil switches are provided so that either one of the two high-tension circuits crossing over on the towers can be switched to either line, or both can be switched to either line at the opposite side of the channel. The four low-tension cables can be similarly handled, although the arrangement provided for them is not quite so flexible as in the case of the high-tension connections.

Since the large cables weigh 1.84 lb. per foot and the material is soft, some care was necessary in stringing these cables to avoid bruising. The fact that the travel on the San Antonio estuary is dense at times, added to the difficulties of operation, but a track on the north side of the estuary running approximately parallel to the direction of the land span, suggested at once the use of a locomotive as a means of putting the necessary tension on the cables. Since the connections at the north tower were permanent and the connections at the south tower were semi-permanent, that is, the attachments there were made to counterweights, a little study showed that by making the permanent attachments to the north tower and to the counterweights, and pulling up to the centre tower, the two connections could be brought together at that point and the eye-bolts passed. By taking one channel span first and then pulling up one land span to meet it, the middle tower was unbalanced only to the extent of the pull on one cable, namely, 7742 lb. Furthermore, this method of stringing afforded a means of checking the accuracy of the calculations, since if, with the counterweights loaded to the calculated strain in the cable at the south tower, after the connections were made at the middle tower, the sag in the estuary span was found to be the correct amount, it could be assumed that the lengths, etc., were correct within close limits. As a matter of fact, the estimated lengths were found very close to the actual when the stringing was complete. Some little changes had to be made, however, in the lengths of the cables, the manufacturer having erred on the safe side by making all cables a little long.

The four reels containing the channel span cables were loaded on a barge and towed to the south tower. The ends here, made up into the dead-ends, were hauled to the top of the south tower and shackled to the chains that led over the chain blocks and thence to the counterweights. Since the elastic limit of the 7-strand steel messenger cable used in the overhead trolley construction was 9500 lb. and the maximum strain in the cable to be installed, namely, the land span, was 8050 lb., it was decided to use the messenger cable, which was furnished in mile lengths, for hauling all cables in connection with the stringing operation. Everything being ready, a launch brought across the channel the end of one of the messenger cables. This being at-

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

tached to the barge, the locomotive on the north side moved slowly to tow the barge across, while the launch was used to help steer. When the barge grounded on the north side the cables were nearly run off the reel. In the meantime four snatch blocks had been made fast to the top and the bottom of the middle tower; a block on the north and a block on the south side at both top and bottom. The messenger wire for pulling the channel span led through the two blocks on the north side of the tower and that for pulling the land span led through the two blocks on the south side of the tower. The dead-ends having been made up on the ends of the cables on the barge, the messenger leading from the top of the tower was secured thereto, and on signal from the launch in the stream that no boats could reach the span within the next ten or fifteen minutes, the locomotive moved slowly away and the cable rose out of the water, was hauled into place and secured. Immediately the corresponding land span cable was raised in the same manner and the two ends brought together. From the description given of the method of connection at the middle tower, it will be remembered that an eye-bolt secured the two spans at this point and that this eye-bolt passes through four eyes in four **I** bars and through a spool insulator. Since the holes in the **I** bars and the eye-bolts were both turned to a close fit, it meant that these ends must be brought together accurately within close limits. A flagman standing at the top of the middle tower gave flag signals to the engineer of the locomotive on the ground a little over a quarter of a mile away. The engineer gave an astonishing example of skill and precision in handling a locomotive that he felt was pulling up nearly to the limit of its adhesion, in that he would watch for a signal from the tower and take up or slack away as little as a fraction of an inch at a time in order that the eye-bolt at the top of the tower could be passed. The whole work was carried out without a slip or a miss and without the slightest damage either to persons or property.

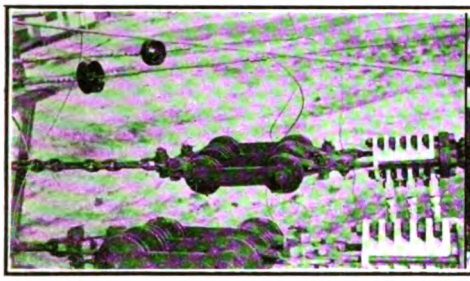


FIG. 8. DEAD-END AND INSULATORS.

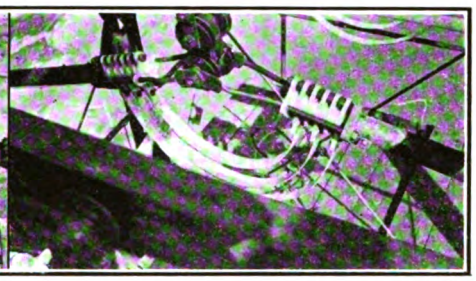


FIG. 9. JUMPER BARS AT MIDDLE TOWER.

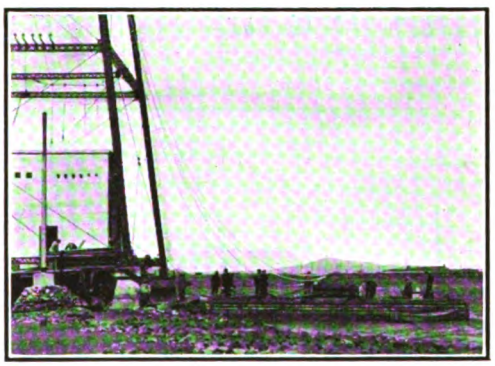


FIG. 10. STRINGING CHANNEL SPAN.

Since the Government requires very close adherence to its specifications, it

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

through the centre of the insulator, from which, by a suitable saddle arrangement, is suspended another electrose insulator that is secured to the hook of the trolley. The vertical components of the weights suspended at this point total 3683 lb. per cable, to carry which 3-ton I-beam trolleys of the ordinary type were installed. They run on the top of the bottom flanges of 9-in. I beams. Jumper bars of 3 by 3/16-in. flat aluminum bar were provided at the middle tower to run between the two dead-ends and thus avoid carrying heavy current through the pin connection above mentioned. In the bases of the north and south towers are placed switching chambers, in which bus-bars and oil switches are provided so that either one of the two high-tension circuits crossing over on the towers can be switched to either line, or both can be switched to either line at the opposite side of the channel. The four low-tension cables can be similarly handled, although the arrangement provided for them is not quite so flexible as in the case of the high-tension connections.

Since the large cables weigh 1.84 lb. per foot and the material is soft, some care was necessary in stringing these cables to avoid bruising. The fact that the travel on the San Antonio estuary is dense at times, added to the difficulties of operation, but a track on the north side of the estuary running approximately parallel to the direction of the land span, suggested at once the use of a locomotive as a means of putting the necessary tension on the cables. Since the connections at the north tower were permanent and the connections at the south tower were semi-permanent, that is, the attachments there were made to counterweights, a little study showed that by making the permanent attachments to the north tower and to the counterweights, and pulling up to the centre tower, the two connections could be brought together at that point and the eye-bolts passed. By taking one channel span first and then pulling up one land span to meet it, the middle tower was unbalanced only to the extent of the pull on one cable, namely, 7742 lb. Furthermore, this method of stringing afforded a means of checking the accuracy of the calculations, since if, with the counterweights loaded to the calculated strain in the cable at the south tower, after the connections were made at the middle tower, the sag in the estuary span was found to be the correct amount, it could be assumed that the lengths, etc., were correct within close limits. As a matter of fact, the estimated lengths were found very close to the actual when the stringing was complete. Some little changes had to be made, however, in the lengths of the cables, the manufacturer having erred on the safe side by making all cables a little long.

The four reels containing the channel span cables were loaded on a barge and towed to the south tower. The ends here, made up into the dead-ends, were hauled to the top of the south tower and shackled to the chains that led over the chain blocks and thence to the counterweights. Since the elastic limit of the 7-strand steel messenger cable used in the overhead trolley construction was 9500 lb. and the maximum strain in the cable to be installed, namely, the land span, was 8050 lb., it was decided to use the messenger cable, which was furnished in mile lengths, for hauling all cables in connection with the stringing operation. Everything being ready, a launch brought across the channel the end of one of the messenger cables. This being at-

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

tached to the barge, the locomotive on the north side moved slowly to tow the barge across, while the launch was used to help steer. When the barge grounded on the north side the cables were nearly run off the reel. In the meantime four snatch blocks had been made fast to the top and the bottom of the middle tower; a block on the north and a block on the south side at both top and bottom. The messenger wire for pulling the channel span led through the two blocks on the north side of the tower and that for pulling the land span led through the two blocks on the south side of the tower. The dead-ends having been made up on the ends of the cables on the barge, the messenger leading from the top of the tower was secured thereto, and on signal from the launch in the stream that no boats could reach the span within the next ten or fifteen minutes, the locomotive moved slowly away and the cable rose out of the water, was hauled into place and secured. Immediately the corresponding land span cable was raised in the same manner and the two ends brought together. From the description given of the method of connection at the middle tower, it will be remembered that an eye-bolt secured the two spans at this point and that this eye-bolt passes through four eyes in four **I** bars and through a spool insulator. Since the holes in the **I** bars and the eye-bolts were both turned to a close fit, it meant that these ends must be brought together accurately within close limits. A flagman standing at the top of the middle tower gave flag signals to the engineer of the locomotive on the ground a little over a quarter of a mile away. The engineer gave an astonishing example of skill and precision in handling a locomotive that he felt was pulling up nearly to the limit of its adhesion, in that he would watch for a signal from the tower and take up or slack away as little as a fraction of an inch at a time in order that the eye-bolt at the top of the tower could be passed. The whole work was carried out without a slip or a miss and without the slightest damage either to persons or property.

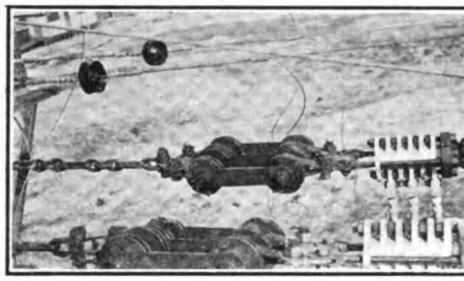


FIG. 8. DEAD-END AND INSULATORS.

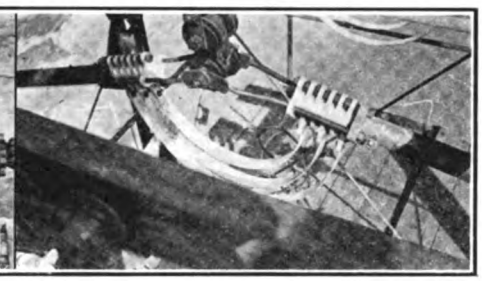


FIG. 9. JUMPER BARS AT MIDDLE TOWER.

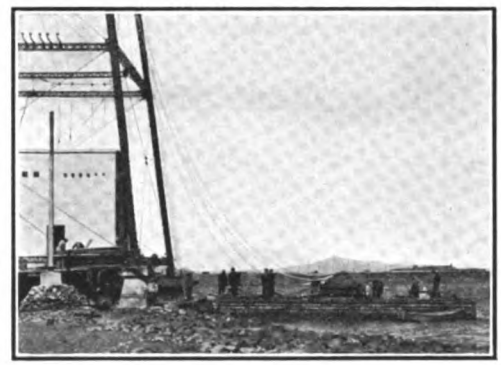


FIG. 10. STRINGING CHANNEL SPAN.

Since the Government requires very close adherence to its specifications, it

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

became necessary to place markers on the two towers at the crossing so that the sag of the cables could be checked at any time. Sheet-iron discs about 12 in. diameter, painted white, with a 3-in. black band drawn horizontally across, are secured to the water side of both towers at a point 200 ft. above mean high water. Through the centre of these discs runs a short length of small diameter pipe which serves to clamp the discs to the tower, and also as a peep-sight. A very accurate determination of the position of the cables with reference to this datum line, can thus be made at any time.

The towers were fabricated under the Harriman lines structural steel contract, and under the common standard structural steel specifications. They were designed by M. J. Meyer, chief draftsman under J. Q. Barlow, assistant chief engineer, Southern Pacific company. All of the erection, both of the cables and of the towers themselves, was performed by the regularly organized forces of the Southern Pacific company, the bridge-men having erected the towers, and the linemen stringing and securing the cables. The constants used in the calculation of the towers are as follows:

Allowable unit tensile strength, 16,000 lb. per square inch.

Allowable unit compressive stress, 16,200 × 57 L r, where L equals the length and r the radius of gyration in the same units.

Unit bearing stress, pins and rivets, 20,000 pounds.

Unit shearing stress, pins and rivets, 10,000 pounds.

Maximum wind pressure, 50 lb. per square foot of exposed surface.

	South tower, lb.	Middle tower, lb.	North tower, lb.
Total horizontal pull at top of tower...	44,280	.....	44,280
Maximum uplift....	108,000	40,000	50,700
Maximum pressure..	177,600	92,000	52,200
Weight of tower....	144,110	106,500	20,000
Weight of counter-weights	29,000	.....	.....
Weight of foundations, struts, and cylinders	.....	129,606	.....

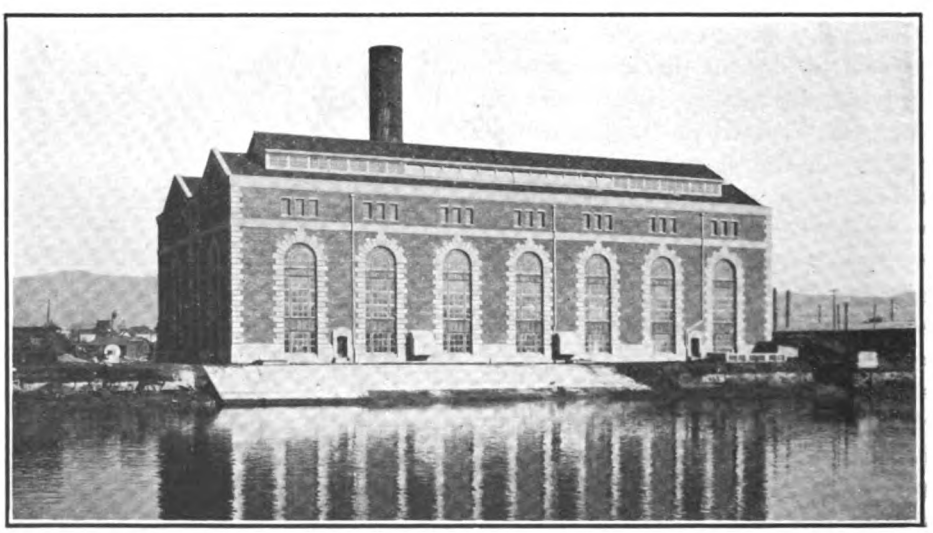


FIG. 11. SOUTHERN PACIFIC POWER-HOUSE.

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Modern Highways*

By AUSTIN B. FLETCHER†

BUILDING good roads has been said to be the very driest subject in the world about which to write, but one of the most interesting activities in which to be engaged. That writer had a proper comprehension of the matter. The subject is very broad, and it would be impossible to do more than touch upon some of the essentials in a paper of this kind. In these days there is no need of a propaganda to show the exigency of good roads. The newspapers and periodicals of the United States reflect the public interest in and the desire for better highways and they are full of articles bearing on road questions. However, instead of urging their necessity as formerly, the discussions now concern how to finance, where to locate, and what is the best type to build. In brief, the present-day road traffic, enhanced by the omnipresent motor car, has made obvious the need of better rural highways.

Five of the Eastern states, previous to the year 1900, adopted laws looking toward the improvement of the country roads, the demand being stimulated by the activities of the organizations of bicyclists. In the next decade not less than thirty other states had joined in the movement, but by that time the bicycle fever had subsided somewhat and the automobile had come. The farmer has profited by the road improvements made possible by activities of the bicyclist and the automobilist, and he has generally supported the good roads cause, but the chief credit for the movement does not belong to him. Now that the farmers are all becoming automobilists, all users of highways have a common interest in them.

California has an area of 158,300 square miles, and, with but one exception, it is the largest state in the Union. Between the extreme northwest and southeast corners the direct distance is 775 miles, the maximum width is 235 miles, the minimum 148 miles, and the seacoast is 1200 miles long. The United States census of 1910 gives the population of the state as 2,377,549, and in a recent publication of the Office of Public Roads at Washington it is stated that at the close of the year 1909 there were 48,069 miles of public roads in the state. Expressed otherwise, California has 20.2 miles of road per 1000 inhabitants and 0.30 of a mile of road per square mile of territory. It is interesting to compare these figures with corresponding data from the same sources of information concerning the little state of Massachusetts, with which I am somewhat familiar. Massachusetts has an area of about 8300 square miles, a population of 3,666,416, and has 20,500 miles of public road. It therefore has 5.59 miles of road per 1000 inhabitants and 2.47 miles per

*Read at the Annual Convention of the Supervisors of California Counties.
†Highway Engineer, California Highway Commission.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

square mile of area. In other words, Massachusetts has more than eight times as much road per square mile as California, but has only one-fourth as many miles of road per 1000 inhabitants. These figures serve to show that while Massachusetts is much more densely populated than California, its road burden is much lighter, since California has nearly four times as much highway to maintain per unit of population. Notwithstanding this, California, in the year 1909, provided by law for a system of state highways to cost $18,000,000, an amount more than twice as great as Massachusetts has expended in the 18 years during which that opulent state has been building state highways. Indeed, I believe that California at one stroke has provided a fund for immediate use in constructing state highways that is greater than that of any Eastern state. In the East, notably in New York and Pennsylvania, systems have been planned which will require ultimately $50,000,000 to $100,000,000 for their completion, but the annual expenditure has been limited to three to five million dollars. Under the California plan, were it possible to do so economically, the whole $18,000,000 might be spent in one year. The rural roads of the future will cost more than those of the past. The automobile has changed conditions, and while a gravel road or a water bound macadam road served admirably at a reasonable cost for maintenance when the vehicles were all horse drawn, the speedy automobile of the present day has made necessary a different type of wearing surface.

Until recently, the prevailing practice, at least in the Eastern states, with regard to the road surfaces of the state highways, was to construct them with a wearing surface of two or more layers of broken stones, small in size, the bottom layer usually no more than 2½ in. diameter and the top layer generally varying from 1¼ to ½ in. diameter. Each course or layer was carefully spread, uniform in depth, and rolled thoroughly with a steam road roller before the next course was placed. By this process, the rolling being done on thin layers, the stones become thoroughly compacted and the void spaces or interstices between the stones are largely eliminated. The final process consists in spreading over the surface of the upper layer of broken stones a thin covering of the screenings which result from the machine-breaking of the stones and which contain a considerable proportion of fine dust, then flushing or grouting the screenings into such voids as remain between the broken stones, rolling the road with the steam roller, and repeating the grouting and rolling until the voids are substantially filled and the roadway refuses to absorb any more of the grout. A macadam road, so built, is sufficiently tight to prevent water from penetrating through it to the foundation, and the stones composing it are locked and bound together so that they do not move or shift under horse-drawn traffic.

Such roads are now usually referred to as 'water-bound' roads, and under the average road traffic conditions, and when the automobiles were not so numerous, such roads could reasonably be expected to wear at least ten years without resurfacing. These roads cost, for the 4 to 6-in. broken-stone surfacing, and not including such items as grading, draining, and foundations, from $2500 to $6500 per mile for 15 ft. in width. It was shown conclusively at the first International Road Congress held at Paris in 1908 that,

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

while little damage is done to such road surfaces by motor cars traveling at speeds less than 15 miles per hour, the roads are injured to an incalculable extent by machines traveling at the usual running speed. Not many automobiles are driven at 15 miles or less per hour on our country highways.

The effect of driving motor cars at high speed has been well told by Col. Bromwell, superintendent of Public Buildings and Grounds at the National Capitol, who said: "These heavy, fast-moving cars cause an excessive wear of the road surface, which is unlike the wear caused by ordinary vehicles, and the road does not tend to repair itself. The wheels are of smaller diameter and greater tread, and have a greater velocity and a greater area at the point of contact with the road surface. The elastic material of which the tire is made has greater coefficient of friction than the tires of ordinary vehicles. The action, therefore, of the driving wheels of the motor car can be compared to that of a powerful revolving brush which brushes away the top surface of the road, acting with a displacing force as high as 200 lb. to the square inch. The dust so ground away is thrown out by the wheels or moved by eddy currents and blown by the wind entirely off the road. In time, all this fine material, whose function it is to fill in the interstices between the larger stones and to compact the road surface, is entirely removed from the road. This action of motor cars on roads is perceptible in dry weather when the cars are traveling at a rate of 10 miles an hour, and at higher speeds is plainly evident. Most motor cars are so geared that it is not convenient nor agreeable to travel on the high speed or direct drive at a rate less than 12 to 15 miles an hour. This fact, as well as the natural inclination of the driver to drive his car as fast as the speed regulations permit, tends to make the wear greater. This wear is also increased by the occasional use of tire chains or other anti-skidding devices."

The road congress referred to was called together chiefly to discuss remedies to lessen the great burden of maintenance caused by the new type of vehicle, and while it did not definitely fix upon a type of road good for all conditions of travel, some of the recommendations which were adopted show the trend of thought of the many engineers there convened. Among the recommendations were the following:

The Congress draws attention to the necessity of constructing the road foundation very carefully with the toughest material; this constituent of the road plays an important part as exerting a considerable influence on the wear and tear of the highway as well as on the upkeep.

While choosing the foundation system, the structure of the subsoil and that of the road, as well as the character of traffic using the road, are to be taken into account.

The Congress is of the opinion that a foundation upon a 10 to 15 cm. (4 to 5 in.) concrete course is especially to be recommended in paving, even when large paving stones are used.

The Congress thinks that it is desirable to continue and to extend the trials made to incorporate tar or bituminous productions into the material of the surface with a view to arriving at some efficient and cheap method.

The Congress recommends that a binder suited to the nature of the road material and reduced to a minimum should be used while the roller is pressing down the surface.

To use as far as possible only hard and homogeneous road materials, regularly broken; to make choice of a binder suitable to the structure of the road materials used, reducing, moreover, this binder to a minimum.

The carriage way of the road of the fu-

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ture should be homogeneous and composed of materials which are hard, tough, capable of resistance and not slipping.

To have the least camber compatible with an easy running off of rain water.

To have moderate gradients with as small a difference as possible between the maximum and minimum, it being understood that in exceptional cases gradient may be sacrificed if necessary to avoid sharp curves.

The radii of curves should be as great as possible, 50 m. (164 ft.) at least, the curves being connected with the tangents by parabolic arcs.

The outside curves should be slightly raised, but so as not to interfere with ordinary vehicles.

Intersections of roads should be visible and well opened out.

Railway-level crossings should be avoided as far as possible, and in all cases should be well opened out and signaled both night and day.

The second congress at Brussels in 1910 indicated that the road builders, all over the world, were still struggling to secure a type of road cheap enough to be used on the main highways in rural districts which will serve the requirements of both motor cars and horse-drawn vehicles.

Narrowing the problem to the needs of our own state, in my opinion the solution is simpler than elsewhere. We have here all sorts of road materials, including gravels, stone suitable for macadam purposes, natural asphaltic oils, bituminous sandstones, all the materials necessary for the manufacture of the best of asphalt, and all of the ingredients needed for the manufacture of hydraulic cement cheaply. All these things are right at hand. With such a selection, the state should soon possess the finest system of rural highways in the world.

There are many miles of road in the mountainous districts where, because of the comparatively few users, it will not be economical to do more than to lessen the gradients, widen the road-beds, increase the radii of the curves, and provide proper drainage. In those places costly surfacings may well be left to the next generation, but such improvements as have been mentioned are urgently needed, both that the dwellers of the hills may market their lumber and crops and that the tourists from other states and our own state may visit in comfort the marvelous mountain country and the magnificent timber of which we are so justly proud.

In other less secluded localities and where the travel is greater, a higher type of roadway should be constructed. There the gravels may be used, and if there is no great amount of motor traffic the water-bound macadam may suffice. In such places the grades will need to be regulated and the road builder always has to think of his culverts, gutters, and ditches, no matter where he is at work. Where the automobiles are more plentiful, but still not very numerous, the type of road known as 'oil macadam' may well be employed. Such a road should cost but little more in this state than its parent, the water-bound macadam, when it is built, as I believe proper; that is, with but a small amount of oil rich in asphaltic content, in the upper course of stone, near the surface, and on the surface itself where it acts as a protecting carpet to the road proper. Again, when the traffic is heavier, and on the main routes between large centres of population, it will be wholly reasonable, in my opinion, to construct a pavement with a thin base of cement concrete and to place on it a thin wearing coat, half an inch or less in thickness, composed of a good asphaltic cement and stone screenings or coarse sand, or a combination of the screenings and sand. Experience in other states also indicates that

Generated on 2024-09-29 23:50 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

the heavy asphaltic oil may be used in place of the more expensive asphaltic cement. Such a coat will, of course, wear off in two or three years, but the cost of renewing it is almost negligible when compared with the cost of maintenance of some other kinds of pavement. When properly made the concrete base should be long lived.

In some places, where the traffic is extremely heavy, it will doubtless be necessary to employ a thicker wearing coat on the concrete base, composed of the well known asphalt mixture so much used for city pavements. A coating of this material, one inch in thickness, under rural highway conditions, when properly laid, should last indefinitely with comparatively no cost for maintenance. These different types of road surfacings so hastily reviewed will doubtless all be used by the California Highway Commission in its work. Of four contracts about to be advertised, one road will be of the high-grade asphalt surface type, two road sections will be built of oil macadam, and one section will only be graded for the present. Within a short time two more sections will be ready where it is proposed to construct the roads with a four-inch cement concrete base and with the very thin wearing surface. To leave generalities and to discuss particulars, I believe the following to be the essentials for modern rural highways in California:

1. A readjustment of the road locations or rights-of-way so as to secure proper alignment and to obviate the necessity for traveling around so many section corners.

2. The elimination of all highway crossings at grade with steam and electric railroads.

3. Rights-of-way of uniform width, preferably not less than 60 feet.

4. Maximum gradients of 7% in the mountainous country and minimum radii of 50 ft. on the centre lines of such roads, with all curves opened out as much as possible by flattening slopes and removing brush and such trees as interfere with the view. A clear sight of at least 150 ft. should be secured wherever it is practicable.

5. The construction of permanent culverts, gutters, and ditches wherever they are needed to prevent water from standing on the roadsides, and on grades to prevent gullying due to the water being carried too far in the gutter, and thus accumulating in volume.

6. The construction of bridges of a permanent character, preferably of reinforced concrete, such bridges to be at least 24 ft. wide in the clear, and so designed that they will carry 16-ton traction engines with a reasonable factor of safety.

7. A minimum width of roadway of 16 ft. which may be traveled safely, such width to apply only to those places in the mountains where there is so much rock as to make a greater width prohibitive on account of its cost. An average width throughout the remainder of the state of 24 ft. on embankments, of 21 ft. in through cuts, and 22½ ft. where the road is part cut and part fill.

8. A crown or cross-camber varying from one inch to the foot, where no surfacing is applied, to less than ⅜ of an inch where bituminous surfaces are used. In all cases the crown should be the least needed to cause the water to run quickly from the road into the gutters.

9. Such type of surfacing as the needs of the locality require, varying from the graded road to the highest type of asphalt paving and varying in width from 15 to 24 feet.

Generated on 2024-09-29 23:41 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

10. The erection of guard rails at dangerous points on grades and on high embankments. In places, guard banks of earth are preferable to the wooden fences, because of their greater permanence.

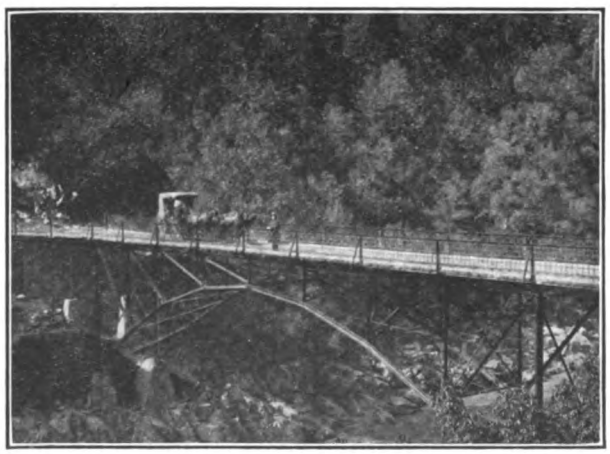
11. The proper trimming of slopes along the roadsides, both old and new, so as to prevent the unsightly gashes now so noticeable along the roads, and also the planting and maintenance of suitable trees indigenous to the locality.

12. The placing of suitable permanent monuments at the time of construction, along the roads, to mark accurately the limits of the right-of-way. Such monuments will be of inestimable value to surveyors. Also the erection and maintenance of guide-boards marked to show places and distances accurately.

13. A proper system of maintenance for the upkeep of the roads after they are built, and the provision of adequate appropriations of money. Such appropriations and such a system should be provided for even before a road is completed, since, even if the wearing surface requires no expenditure for some time (a rather unusual condition) the gutters, culverts, and slopes will always need attention.

I believe the essentials listed are recognized by the California Highway Commission and that in general the work to be done by the Commission will conform to them.

The law under which the Commission is working provides, roughly speaking, for the construction of from 2500 to 3000 miles of state highway. Taking the larger mileage into consideration, the permissible average cost per mile would be $6000. Since the counties have in so many instances offered to construct the bridges and to furnish free rights-of-way, the task of the Commission seems more hopeful, but when one considers that the Los Angeles county work, the Sacramento county work, and that of Santa Barbara county has nearly all cost more than $9000 per mile for 'oil macadam' work, it will be recognized that there will have to be much unsurfaced work in the mountains to reduce the average to the $6000 per mile apparently contemplated by the State Highways Act.



HIGHWAY BRIDGE ACROSS SOUTH YUBA RIVER.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

San Diego Water Supply System*

By M. M. O'SHAUGHNESSY†

SAN DIEGO claims to be the cradle of white civilization on the western coast of the United States. It was discovered by Viscaino in 1602 and rediscovered by Cabrillo in the year 1642. Junipero Serra, one of the Franciscan fathers and a missionary from Mexico, founded the original mission of San Diego, the first mission in California, in the year 1769. This mission is situated on the north slope of the valley of the San Diego river, about six miles east from the ocean. One of the first problems which confronted the pioneers of this mission was the development of a supply of water for their own use and that of the growing community about them.

To solve this problem, the fathers, in the year 1770, built a dam across the San Diego river about six miles east of the mission at a site where good bedrock was found. The dam was made of brick and lime mortar, 244 ft. long, 13 ft. wide, and 16 ft. high, and the fact that it exists today, after all these years, is convincing testimony of the fidelity of the workmanship of the pioneer constructors of California. This dam was used to turn the waters of the San Diego river into an open masonry conduit, which led down along the north side of the San Diego river to a point behind the mission; thence it was distributed over the surrounding areas of cultivable lands and gardens. The conduit was 28 in. wide at the top, 15 in. at the bottom, and 28 in. deep, and was lined with excellent brick and cement mortar. Apparently powder and drill-steel were not employed, as this structure was erected on the talus of loose materials formed by the decay of the adjoining bluffs. Various wars and battles affected the fortunes of the mission under Mexican rule, and the frequent Indian depredations, so that in the past seventy years the mission conduit and dam have been permitted to go into decay and are not now used.

The next stage in the development of the water-supply in San Diego was subsequent to the extension of the Santa Fé railway into this part of the state in 1886, and at that time two water-supply works of considerable magnitude were projected. The first was that of the San Diego Flume Co., which was intended to store the water of the San Diego river by constructing dams in the mountains and leading the water, by means of flumes, to the settled areas bordering on the bay of San Diego. This scheme was started with great expectations from the promoters, but resulted very badly for the shareholders, as the entire property, representing an original investment of $1,600,000, was recently sold for about $150,000. The weakness of the project was the small amount of storage provided, only 3,739,000,000 gallons in a

*Address delivered before the San Francisco chapter, American Society Civil Engineers.
†Consulting Engineer, Nevada Bank Building, San Francisco.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

reservoir with a surface area of 959 acres, formed by building a dam 35 ft. high at an elevation of 3739 ft. Another unfortunate part of the project was the location of this dam on one branch of the watershed of the San Diego river which controlled an area of only 10½ square miles, while the whole shed available near the old mission dam of the pioneer fathers, ten miles from San Diego, had an area of 340 square miles. From this dam, situated in the mountains 50 miles from San Diego, the water was permitted to flow down the stream-bed a distance of 12½ miles and was picked up by a diverting dam at an elevation of 804 ft., and from this diverting dam was led by a wooden flume 6 ft. wide by 16 in. deep along the side of the river canyon to the vicinity of La Mesa, a distance of 37 miles. The greater part of this flume, with a carrying capacity of 10,000,000 gallons per day, lies on a graded bench on the surface of the ground, and there are perhaps six miles of very high trestles where the structure crosses intervening valleys, in some places over 60 ft. high. The grade of the flume is about 5 ft. per mile, and the flume spills into La Mesa reservoir at an elevation of 435 ft. The reservoir is 96 acres in area and has a storage capacity of 749,000,000 gallons. It was formed by building a hydraulic fill dam 65 ft. high, faced with asphalt concrete.

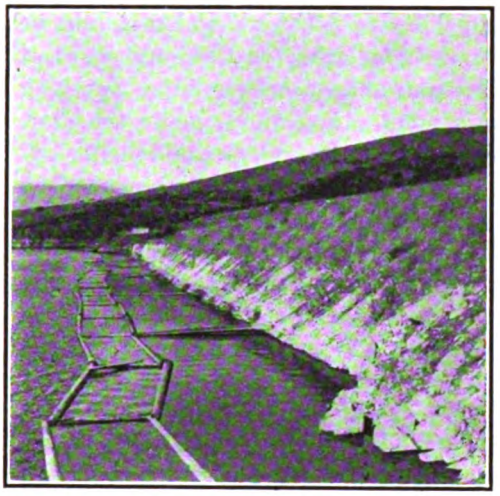
The promoters of this scheme sold water rights in connection therewith in El Cajon valley at a price from $600 to $800 per miner's inch, with an annual rental in addition of $1 or $2 per acre for each acre of land irrigated. Owing to the small storage capacity provided by the reservoir, when dry years came the reservoir was empty, and there was no water to deliver to the people owning the water rights. As a result many orchards and other properties were ruined by the inefficiency of the system. In years of plenty, however, the flume company sold the surplus water to the city of San Diego, which used this water for its supply part of the time and occasionally used water pumped from the sand beds of the San Diego river inside of the city limits. The quality of the flume company's water, after passing through 37 miles of open flume in the summer, was decidedly bad, as it was heavily charged with algae and other objectionable growths, and it was a source of constant complaint and dissatisfaction to the citizens. Between the bad quality of water and the shortage through years of difficulty from short rainfall and small run-off, and for many other reasons, the lives of the water company and its consumers were neither happy, harmonious, nor profitable, so that the owners went out of business about two years ago under the terms stated. A new owner now has the property and is contemplating schemes for its improvement.

The next water development in San Diego was that of the Sweetwater Water Co., which was owned practically by the then directors of the Santa Fé Railway Co. in 1886. This company purchased about 20,000 acres of land in the neighborhood of National City for a very moderate price, exploited it for orchard purposes, and started quite a settlement. Having bought the lands cheaply, they sold them with water attached for about $300 per acre and also subject to an annual water rental, the rate of which was fixed by the County Board of Supervisors. To solve the water question, they built the well known Sweetwater dam, at an elevation 150 ft. above the sea, to a height

Generated on 2024-09-29 23:53 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

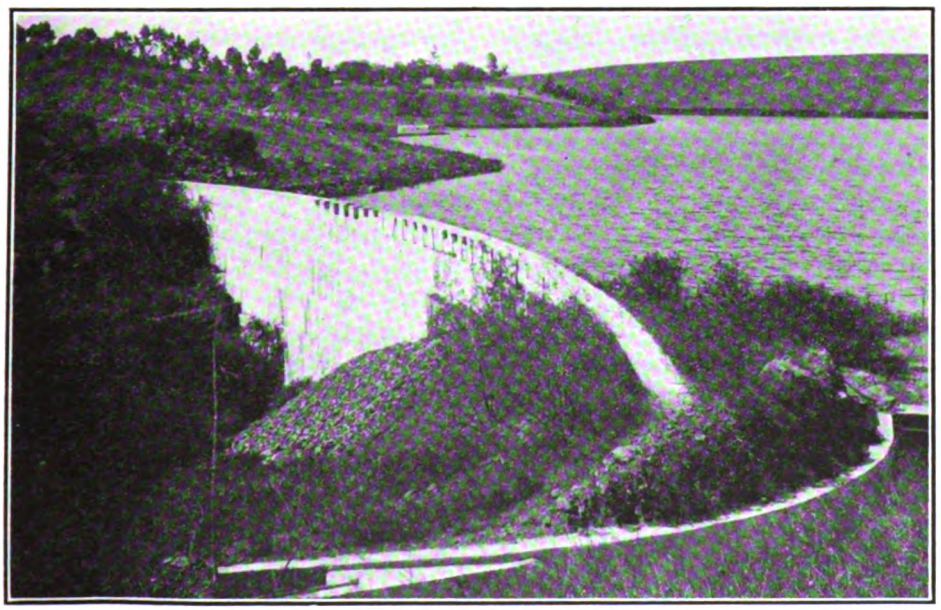
of 90 ft., and this created a storage capacity of seven billion gallons of water. Without any accurate knowledge of run-off or yearly rainfall, the men concerned presumed that the construction of a dam with this storage capacity would solve the question of water-supply for the lands they were selling. After a few years of generous rainfall, which were enough to fill the reservoir and top the dam, years of light rainfall and run-off came, so that the bottom of the reservoir was used for grazing purposes. This spelled disaster for many of the orchards and settlements below the work and created intense ill feeling among the people, as they imagined they were intentionally deceived by the water company into paying high prices for land with a water-supply which was neither permanent nor continuous.

These two water companies have been a source of much litigation in San Diego county, and the records of both the Supreme Court of the State of California and the United States Supreme Court bear testimony to the vigor with which the legal aspects of these water conditions have been fought. Recently the



LOWER OTAY DAM; 150 FT. HIGH, ROCK-FILLED.

Sweetwater dam has been raised 20 ft., under Mr. Schuyler's direction, so it now has eleven and a half billion gallons capacity. The observed rate of



UPPER OTAY DAM; ARCHED CONCRETE.

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

silting in this reservoir for 20 years was 0.5% per year.

A good many worthy citizens of San Diego have also been laboring under the delusion that because the climate is so equable and pleasant, water should be very cheap, whereas the long years of drought and clear sunshine, favoring maximum evaporation, make the storage of water an indispensable and very expensive undertaking, and, placed on a proper basis, the water rates in San Diego county should be higher than in any other city in California, whereas, unfortunately for the welfare of the owners of the water properties, the reverse is the case.

I now come to the foundation of the Southern California Mountain Water Co. About 1886 and 1887 the well known 'Wright' law was passed by the legislature at Sacramento, to enable districts to be promoted, and, by issuing bonds, build storage works for impounding water and to distribute it to the people included within the respective districts. Several were promoted in San Diego county, but only one, the Escondido irrigation district, has survived. This is now free from debt, as the holder of the bonds, while involved in continuous litigation, finally cashed out on the basis of 50 cents on the dollar, realizing $175,000 on his investment of $350,000. The next two districts formed were the Otay irrigation district and the Jamacha irrigation district, which met the fate of nearly all of the other districts by absolute failure.

About this time a gentleman named Babcock came to San Diego from Indiana. He was a man of large imagination and extensive energy, and possessed a very small opinion of the value of engineering assistance in executing any engineering problem. He is the gentleman who built the two Otay dams and he should certainly be credited with originality in using for the first time in dam construction the steel plate with a concrete shield for a water-tight diaphragm through the centre of the lower Otay dam. He did this work from 1894 to 1897.

The upper Otay dam is of original and bold design, and is made of reinforced concrete, built of the arched type, being curved up-stream with a radius of 359.26 ft. from the centre line of the crest. The dam is only 4 ft. thick at the top and 14 ft. thick at the base, 84 ft. high, and stepped with offsets on the down-stream side. Two tiers of steel plates were placed longitudinally on the foundation at the axis of the dam, while above this at intervals of 2 ft. vertical, 1¼-in. railway cable for reinforcing was placed. The highest cable was 5 ft. from the top of the dam. The concrete near the base was made of a very rich mixture, becoming gradually poorer as it approached the top. This dam is a splendid example of efficient engineering construction and was built by C. M. Bose under the general direction of Mr. Babcock. The design of this dam was not original, as it is practically a duplicate of the San Bernardino dam, built by F. E. Brown in 1883-1884, which still survives and is in good condition.

The next dam built by Mr. Babcock was the Chollas. It is situated along the route of the main supply-pipe into San Diego from the lower Otay reservoir, and is built across the Chollas valley, about four miles from the city limits. It is situated on a tract of land 180 acres in area, a short distance east of the filter plant. At the 23-ft. contour, the Chollas reservoir contains over ninety million gallons of water, being

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

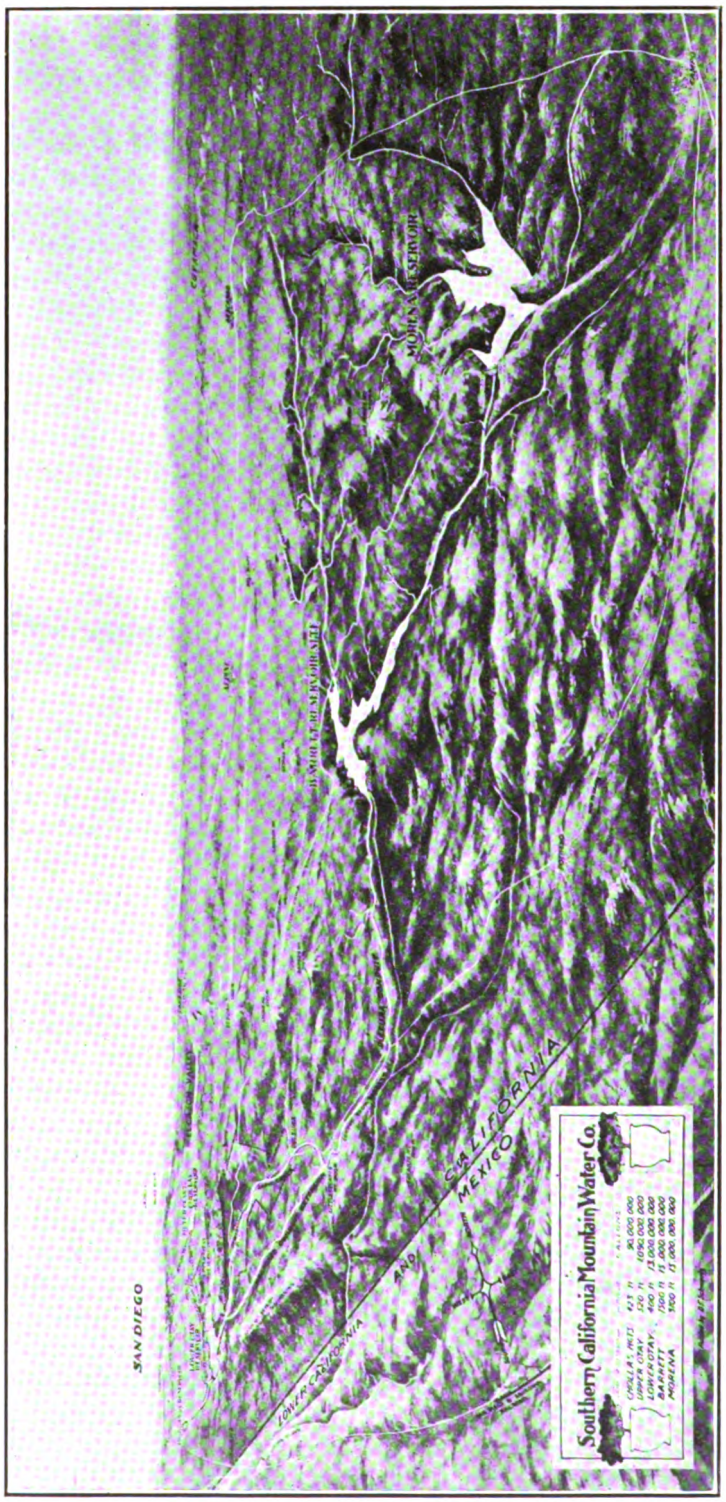
about five times the capacity of the new University Heights reservoir, which has cost the city about $110,000. The Chollas dam is of the earth-fill type, with a ¼-in. steel-core plate anchored into a foundation wall of concrete. It is 56 ft. high above the foundation and 526 ft. long on top, and was completed between June and September 1901, under the direction of E. F. Tabor as engineer. It is connected with the main 30-in. pipe from Otay by means of a reinforced-concrete outlet tower and 24-in. cast-iron outlet pipe.

The Morena dam was started in 1896 by Mr. Babcock, who at this time interested the Spreckels brothers to the extent of contributing one-half of the expense of the construction works. Before the work was commenced, a contract was made with the city of San Diego to supply water to the extent of 1000 miner's inches, or 13,000,000 gallons per day, at a yearly price of $1,500,000. Various estimates were made of the cost of this structure, some as low as $90,000. Very little thought had been given to the fact that the distance from San Diego by wagon-road was nearly 60 miles, and that hauling freight over this length of mountain wagon-road with reverse grades was worth one cent per pound or $20 per ton. As a barrel of cement alone weighs 400 lb., it can readily be seen that freighting would add $4 to the cost per barrel of cement for delivery at the damsite. Many other items in estimates were found to be equally erroneous, so after the foundation toe wall was in, and a large amount of money had been expended for two years in starting the structure, work was suspended in 1898, but was resumed in May 1909, under my direction, and was finished in May this year, after three years of continuous work.

My first connection with the company was in January 1897, when I was retained by Mr. Spreckels as consulting engineer to examine the site for a dam at Barrett, where it was proposed to build a masonry structure, and excavations were in process of being made. The Barrett damsite is on the Cottonwood river, 10 miles west of Morena, in a granite formation. The granite on the west side of the canyon and below the stream-bed is dense and perfectly clean, but on the east abutment there is a talus of decomposed material the extent of which has not been thoroughly explored, but work is under way now to ascertain the nature of it by driving exploration tunnels and making borings. Four or five efforts were made by Mr. Babcock and his engineers to locate a damsite, but no thorough study was made of the matter, and, as it was of such great importance, I recommended suspending decision on the matter until the nature of the foundations had been thoroughly proved.

In May 1907 I assumed charge both as chief and consulting engineer of the company and built the Dulzura conduit. This conduit leads from the Barrett damsite on the watershed of the Cottonwood for about 13 miles to the divide between the Cottonwood and Otay watersheds at Dulzura, and discharges into Dulzura creek, which flows into the lower Otay reservoir. As constructed, it is 60 ft. above the stream bed at Barrett. It was originally intended to be 82 ft., but after making a study of the situation, I found that this 22 ft. in extra depth in the Barrett reservoir could be utilized by building the conduit on the flatter grade of 4 ft. to the mile and making a deeper tunnel at the western terminal at Dulzura. The grade originally intended for this con-

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN



SOUTHERN CALIFORNIA MOUNTAIN WATER CO.'S SYSTEM; BIRDSEYE VIEW.

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

duit was 5 ft. to the mile, but I found that on the 4-ft. fall in 5000, which is the grade of the completed work, there is a velocity of 4 ft. per second, great enough to scour out the bottom of the conduit. This is all constructed on hardpan, for which a bench was first cut out of the mountain-side and the conduit afterward excavated to the required depth, and it was not thought that the effects of scour with such a light gradient would be perceptible. There are about two miles of granite tunnel along the route of this conduit which are in the hardest kind of rock and which cost, for a width of 6 ft. and a height of 7 ft., an average of about $20 per foot to excavate. The rock, however, is so hard and impervious that it was unnecessary to line it.

The figure 4 is a dominating figure in this work. The grade is 4 ft. fall in 5000. The depth is 4 ft., the velocity nearly 4 ft., and the capacity 40,000,000 gallons of water in 24 hours. As the question of placing a dam at Barrett was a matter that required time and study, it was planned to make temporary intakes up both streams to feed the conduit and defer the location of the dam until its exact type and position could be finally and wisely decided. Several sand traps have been arranged near the intakes to trap the sand and floating mica which flows into the stream-beds, especially during freshets. In spite of this arrangement, the lighter and finer mica is still swept along into the current, but not in such quantity as to be of serious moment. This conduit was commenced on August 1, 1907, and completed January 3, 1909, being under construction for practically 18 months. The western half, including the four tunnels, was built by contract, but the remaining half and all the concrete work was done under the personal supervision of myself and my assistants. Expansion joints were laid in the concrete every 12½ ft. which have proved very effective in preventing any cracks. About one-half mile of the conduit, at different points where subject to slides, has been roofed with a concrete slab 6 in. thick, reinforced with steel rails. In the future it is proposed to roof the entire conduit.

The conduit line from lower Otay to San Diego commences at the outlet from the lower Otay reservoir at an elevation of 400 ft. above the sea, and traverses the country between lower Otay, Bonita, Chollas valley, and San Diego. To obtain the best delivering capacities in this conduit, and preserve an efficient hydraulic grade line, four tunnels were bored through the intervening hills, aggregating 6735 ft. in length. For the first two and a half miles a 40-in. pipe leads from the outlet tunnel to the junction with the Coronado pipe-line; thence six miles of 36-in. wooden stave pipe leads to Bonita valley, across which there is three-quarters of a mile of 32-in. steel pipe under high pressure. Thence to the Chollas filtering plant the pipe is of 30-in. diameter, aggregating 15.16 miles from the Otay lake. From the junction at Chollas into the filter plant and balancing reservoir four miles of 24-in. pipe is laid into the University Heights reservoir, where it is delivered to the city distributing system, all water being measured by means of a Venturi meter. The first 8½ miles of this pipe to Bonita has been under continuous pressure since August 12, 1901, the maximum head being 293 ft. For the high-pressure pipe the wood staves were dressed from 3 by 6-in. redwood. The staves were bound together with iron bands ½ in. diameter, sometimes spaced as close together as one inch

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

from centre to centre of each band.

The wooden pipe is in a splendid state of preservation, and where it runs through the tunnels, aerating shafts have been made to promote ventilation, so that practically no deterioration from rot has taken place, showing the result of very conscientious and efficient workmanship in the construction of this pipe. The balance of the pipe-line connecting Chollas and the town was completed in 1905, water for permanent municipal consumption being turned on in August 1906.

Notwithstanding the character of the drainage area from which the water-supply of the Southern California Mountain Water Co.'s system is obtained, the company decided to install the most modern type of filtering plant used in the United States. The agreement which the water company had made with the city of San Diego was to furnish a good, pure, wholesome supply of water, and, although under no obligation to do so, the company has erected a system of mechanical filtration combining sedimentation, filtration, and aeration, from which water of the purest quality known to science is delivered into the city mains. The filtration plant is situated about four miles from San Diego in the Chollas valley and has a capacity of 7,000,000 gallons per day, and is known as the New York Jewel horizontal pressure system. This plant is contained in a substantial building with a concrete floor and foundation, and sufficient spare capacity has been provided so that in the future its capacity can be increased to 12,000,000 gallons per day without disturbing the present arrangement. The plant consists of a battery of 10 filters, each 8 ft. in diameter and 20 ft. long. They are made of steel plates ½ in. thick. The filtering medium in each filter contains over 30 tons of pure silica sand brought to San Diego from New Jersey. The water enters the top of the filters and, percolating through the layers of sand, goes through the lateral pipes into large mains, foreign matter and detritus remaining on top of the sand. Cleansing the filters from impurities deposited is accomplished by simply reversing the valves, when all foreign and objectionable matter is blown out of the filters into a trough to waste pipes. The whole operation of washing occupies 9 minutes and is the work of one man. This cleansing takes place every 24 hours, but once every 48 hours would be sufficient, as the water is practically free from impurities and simply needs aeration. The engineering work in completing the Otay pipe-line and building the filters was supervised in 1905 and 1906 by A. Ervast.

San Diego now boasts of the purest water-supply in the state of California, and the growth and prosperity of the city are assured thereby. Its population on July 1, 1910, was 42,500. At a low estimate the population inside of the city limits the first of July this year will be 55,000, all of whom, in addition to 5000 people in the immediate suburbs, depend on this source of supply for existence. Owing to the lack of storage from which other companies have suffered in the past, our company, on my recommendation, has adopted the policy of conserving a seven years' supply in its storage reservoirs for the continuous use of its patrons. This would seem, doubtless, to be an extreme policy to many engineers, but looking back at the experience of the Sweetwater company through a seven-years dry spell, it seems to me to be the only sane and prudent policy to adopt in this situation.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

Swamp and Overflow Lands in California

By MYRON H. PECK*

THE area of overflow or swamp lands in the Sacramento and San Joaquin valleys was estimated at 1,250,000 acres in 1873. This estimate, based on confessedly insufficient data, was made by a board appointed by the President of the United States to study the problem of irrigation in California. In 1888 Marsden Manson stated that there were from 1,750,000 to 2,000,000 acres in the state. In 1888 C. E. Grunsky estimated that there were about 1,000,000 acres in the San Joaquin valley, not including lake areas, while in 1904 the Dabney commission stated that there were 1,000,000 acres in the Sacramento valley. Two million acres is evidently about the extent of such lands in the whole state. In 1850 the President approved an act of Congress granting swamp lands to state governments. The act reads in part:

"To enable the several states (not including Kansas, Nebraska, and Nevada) to construct the necessary levees and drains to reclaim the swamp and overflow lands therein, the whole of the swamp and overflow lands made unfit thereby for cultivation, and remaining unsold on and after the 28th day of September, A. D. 1850, are granted and belong to the several states respectively in which the lands are situated; provided, however, that said grant of swamp and overflow lands, as to the states of California, Minnesota, and Oregon, is subject to the limitations, restrictions, and conditions hereinafter named and specified as applicable to said three last-named states, respectively." The conditions referred to are:

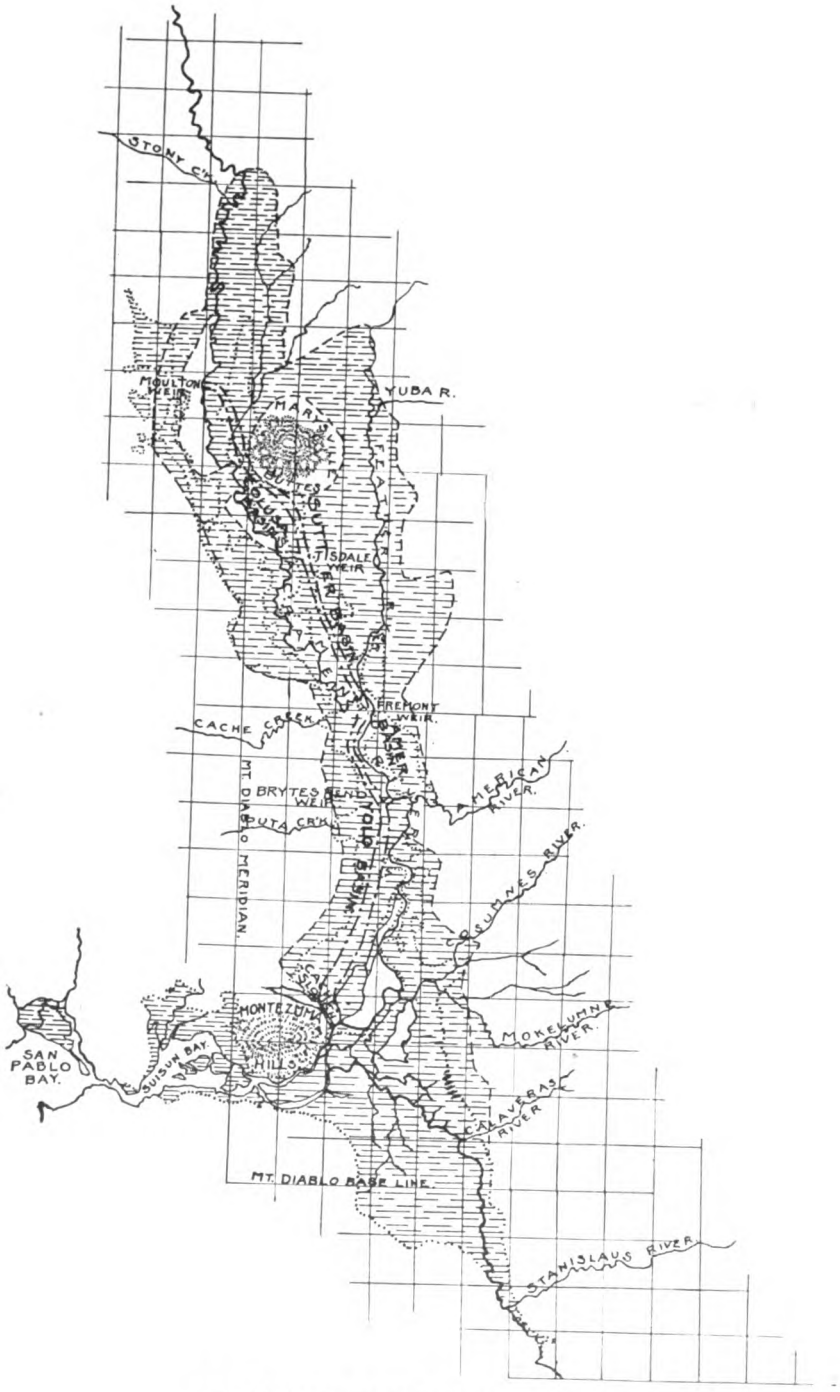
"The proceeds of said lands, whether from sale or by direct appropriation in kind, shall be applied exclusively, so far as necessary, to the reclaiming of said lands by means of levees and drains." There are other restrictions and conditions, which are of no importance so far as this paper is concerned.

In 1873 the Supreme Court of California acknowledged the conditions of the grant in the following words: "In accepting this grant the state was bound to carry out in good faith the objects for which it was made, and the Legislature has at all times recognized the binding force of the obligation. * * * It would practically defeat the whole cause of reclamation contemplated by Congress, if the mere sale of land to private proprietors should have the effect to exempt it from the power of the Legislature to reclaim it. Such a result would be in flagrant violation of its duty toward the Federal government." (Kimball *v.* Reclamation Fund Commissioners, 45 Cal., p. 344, Jan. 1873.)

An excellent summary of state legis-

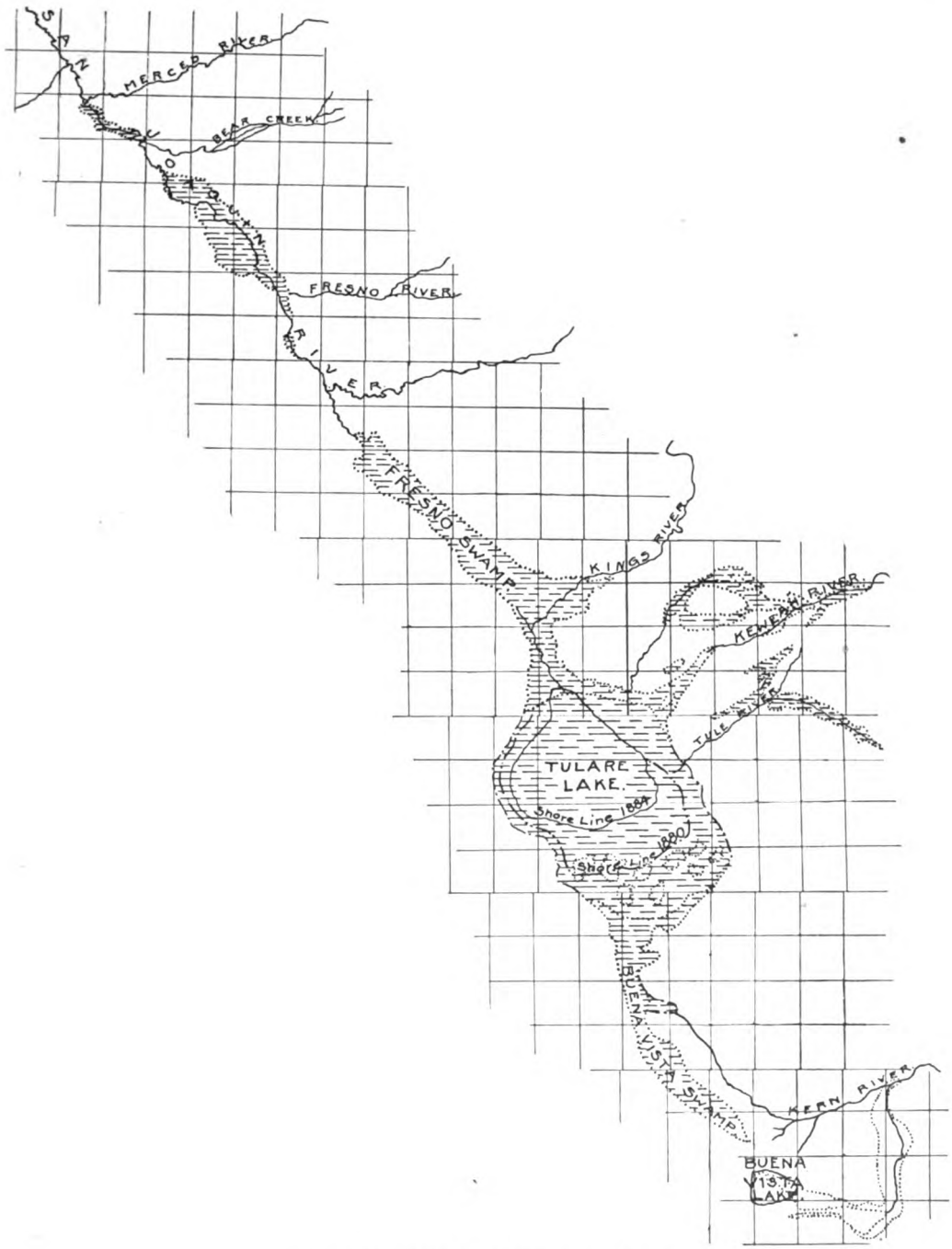
*Civil Engineer, Hearst Building, San Francisco.

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN



SACRAMENTO VALLEY OVERFLOW LANDS.

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN



SAN JOAQUIN VALLEY OVERFLOW LANDS.

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

lation concerning swamp lands can be found in a paper by E. F. Adams, *Transactions* of the Commonwealth Club of California, Vol. IX, No. 5. Mr. Adams summarizes the policies of the state as follows:

1. A short period of entire neglect of the obligation to reclaim.

2. The years from 1851 to 1861, in which the state granted lands to individuals for reclamation virtually by such methods as they might devise, either individually or in association with others.

3. The period from 1861 to 1866, in which the state undertook to supervise and control the work of reclamation districts.

4. The period from 1866 to 1868, in which the state, having transferred the swamp and overflow lands to the counties in which they were situated, and washed its hands of the whole business, permitted the organization and operation of districts under the imperfect laws then in force.

5. The period from 1868 to the present time (1909), when under workable laws gradually modified and perfected, the districts have continued to operate under the general oversight of the Board of Supervisors, but with no direct responsibility to any central authority. Under this law each district has looked out for itself, regardless of others, of the interests of navigation—except as compelled to do so by the Federal authorities—or of the general welfare.

Before considering further what has been done toward reclaiming the swamp and overflow lands of the state, it will be well to classify them. A glance at the map will show that the Sacramento river basin contains most of these lands; next in importance are the swamp and overflow lands in the vicinity of Tulare lake; then come the overflow lands of the lower San Joaquin, and the comparatively small areas of tidal marsh on Suisun bay, San Pablo bay, and Humboldt bay (not shown on the map). Naturally, the Sacramento valley lands have received more attention from the public and the Government than those of the other localities and will be considered first.

In 1880 the state engineer, William Hammond Hall, in consultation with a board consisting of Gen. Alexander and Col. Mendell of the Corps of Engineers, and M. J. B. Eads, reported in favor of confining the river between high levees, so that the main channel would carry all floods. Temporary relief channels were to be provided, until the main channel should be dredged and scoured to a sufficiently large cross-section. This plan was never accepted by the state legislature. In 1894 Marsden Manson and C. E. Grunsky, consulting engineers to the Commissioner of Public Works, reported in favor of a system combining rectification of the main channel, so that it should carry as much flood flow as possible, with a series of by-pass channels confined by levees, which should take the surplus flood-waters over weirs in the river banks. The maximum flood flow assumed below the mouth of the by-pass system at Cache slough appears to have been 200,000 second-feet.

After the great floods of 1904 the Governor appointed a commission consisting of Maj. Dabney, chief engineer of the Yazoo, Mississippi, levee district, H. B. Richardson, state engineer for Louisiana and member of the U. S. Mississippi River Commission, and Maj. Chittenden of the Corps of Engineers, to suggest a plan of flood control. M. A. Nurse, engineer of the Commissioner of Public Works, was later added to

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

the Commission, and Col. W. H. Heuer of the Corps of Engineers assisted unofficially. This commission assumed a flood flow of 250,000 second-feet below Cache slough, and recommended a system of channel rectification and levees similar to that of 1880.

In 1893 the California Débris Commission was created by an Act of Congress: "(a) To regulate hydraulic mining so as to permit the resumption of that industry so far as is compatible with the protection and restoration of the navigability of the Sacramento, Feather, and San Joaquin rivers, and the prevention of damage from overflow. (b) To improve the navigability of all the rivers of this system * * * with a view to restoring as near as practicable, and the necessities of commerce and navigation demand, the navigation of said rivers to the conditions existing in 1860. (c) To afford relief in flood time and to provide sufficient water to maintain scouring force in summer season."

The first two objects having been, in the opinion of the Commission, attained, a report dealing with flood control was submitted to Congress in 1911.

The essential features of this plan are similar to those of the Manson-Grunsky project, except that a maximum flow of 600,000 second-feet below Cache slough is provided for. They are summarized in the report of the Commission as follows:

"(a) Dredging to flood channel section that portion of the river below Cache slough, with rectification of the channel by a cut-off at Horseshoe bend.

"(b) Improving the channel at various points, especially at the head of Steamboat slough, so that the river from Cache slough to the American river will have a capacity of about 100,000 cubic feet per second.

"(c) Constructing a weir opposite the mouth of the Feather river and connecting it by means of a permanent by-pass in Yolo basin with Cache slough, this by-pass and weir to be of sufficient cross-section to carry all flood waters that cannot be carried by the present river below the above weir.

"(d) Constructing a weir at Moulton's Break, about 13 miles above Colusa, and connecting it by means of a permanent by-pass in the Sutter and Butte basins with the Sacramento river at its junction with Feather river, this weir and by-pass to be of sufficient capacity to carry all flood-waters that cannot be carried by the present river below this weir.

"(e) Increasing the cross-section of the river above Moulton's Break by raising the levees and placing them farther apart, so that the increased cross-section will provide for the estimated discharge.

"(f) Constructing a weir at Brytes bend, two miles above the mouth of the American river, and connecting it by means of a permanent by-pass with the Yolo basin by-pass, this by-pass and weir to have a capacity of about 70,000 cu. ft. per second, or sufficient to carry the excess flood-water that reaches that point.

"(g) Reconstructing the present Tisdale weir and connecting it by means of a permanent by-pass with the Sutter-Butte by-pass, the weir and by-pass to have a capacity of about 35,000 cu. ft. per second, or sufficient to carry the excess water that reaches that point.

"(h) Confining to their present channels by means of levees the flood-waters of all the important tributary streams.

"(i) Collecting the hill drainage in intercepting canals and conveying it to the rivers or by-passes at convenient points.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

"(j) Providing for the drainage of the basins by placing culverts with gates at various points in the by-pass levees."

The by-pass system and weirs proposed are shown on the map herewith. It should be remarked here that the Sutter by-pass lies largely in marsh, and the lower end of the Yolo by-pass is in tule marsh, so that a large part of the 60,000 acres in the by-pass channels will have at least as much value when the system is finished as now. The weirs are to be placed about 16 ft. above extreme low water, or 6 to 8 ft. below present maximum flood-stage. Therefore the by-pass channels will be dry except during seasons of high floods. Under present conditions the river overflows into the American and Yolo basins at a height 4 ft. lower than the proposed weir crest. Part of the Sutter basin by-pass is below the crest of its exit weir, but it seems probable that this will be gradually silted up, so that all the land in by-pass channels will eventually be available, at least for pasture, during dry seasons.

The only criticism of the general plan that suggests itself concerns the location of the weir that is expected to take the excess flood-water of the American river. The main channel of the Sacramento river, between the Feather and American rivers, is to have a capacity of 50,000 sec-ft. The maximum flood flow of the American is estimated at 120,000 sec.-ft., giving 170,000 sec.-ft. to be taken care of below the mouth of the American. The main channel is to carry 100,000 sec.-ft., and the weir and by-pass to carry the remaining 70,000 sec.-ft. are situated at Brytes bend, two miles above the mouth of the American. This two miles of river channel might, by widening, be converted into an equalizing chamber; but the low-water navigation channel would be practically destroyed. There is no obvious reason, except expense, why the weir should not be opposite the mouth of the American.

The overflow lands bordering Tulare lake and the Fresno swamp have been largely reclaimed by private landowners and by nature. Tulare lake itself is said to be receiving water now, but was entirely dry for some years previous to 1898. As shown on the map, Tulare lake sometimes receives water from Kings, Tule, Kaweah, and Kern rivers. The whole flow of Kern river is divided between irrigation in the Kern river delta and storage in Buena Vista lake, converted into a reservoir. When there is overflow from Buena Vista lake it is carried west of the reclaimed Buena Vista swamp by a canal and discharged into its northern end, thus reaching Tulare lake. Tule and Kaweah rivers are also unimportant contributors, practically all of their flow being used in irrigation. Fortunately the spring and summer floods of these rivers coincide with the period of greatest use of water in irrigation, and the low-water flow of Tule river is only 450 sec.-ft. (1878 to 1884), and that of Kaweah river is 30 sec.-ft. King river is the most important feeder to the lake, but at all times a part of its flood flow goes directly to Fresno swamp, and the diversion of all of the flood flow would be a simple matter. From 1878 to 1884 the minimum monthly mean flow was 220 sec.-ft., the medium stage 1000 to 2000 sec.-ft., and the maximum monthly mean 4000 to 8000 sec.-ft. In 1896 to 1897 the minimum monthly mean was 250 sec.-ft. and the maximum 22,750 sec.-ft. The greatest rate of flow during all this time was 30,000 sec.-ft. There

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

is a fall of about 60 ft. from the entrance of Kings river to the Fresno swamp and the northern end of the swamp, a distance of about 35 miles. By constructing a flood weir at the entrance to Cole slough, closing Clark's fork, and enlarging and extending Zalda canal or slough, the whole flood flow could be diverted to the San Joaquin. The lowest part of the lake bed is nearly 40 ft. lower than its outlet, and the excess waters of Kern, Tule, and Kaweah rivers would still collect there unless a system of drainage, by pumping or otherwise, were installed. In this connection a record of the fluctuations of water-level in Tulare lake will be quoted from the report of C. E. Grunsky on 'Irrigation Near Bakersfield':†

"In 1853, after several wet seasons, the lake was full, though probably not so high as subsequently, in 1862 or 1868. From 1853 until 1861 there was a gradual subsidence of the low-water stage of the lake. The rate at which this occurred cannot now be determined. In the fall of 1861 the water surface of the lake was at the elevation 204 ft. above sea-level (low water of Suisun bay), if the testimony of residents at the lake at that time in reference to the rise of water the following winter, can be relied upon. The unusually heavy rainfall of the winter of 1861-62 caused the lake to rise to the highest known stage—220 ft. Its area was increased from about 300 to about 800 square miles, and 300,000,000,000 cu. ft., or 6,885,000 acre-feet, were added to its contents. It continued to overflow at least until the spring of 1863, but then rapidly fell to about 11 or 12 ft. below its highest stage, which was its condition in the fall of 1867. The inflow of water during the wet winter of 1867-68 again brought the lake nearly, if not quite, to the high-water stage of 1861-62.

"The water surface fluctuated between 211 and 217 ft. in the years 1872 to 1876, then receded rapidly to the lowest known stage—192 ft.—in November 1883. From that time to this (1898) the lake has not received sufficient water to cause it to overflow. It is generally believed that the diversion of water for irrigation purposes from Kern, Tule, Kaweah, and Kings rivers has been the cause of the decrease of water volume in the lake, but this is not true. Although such diversion must produce some effect on the lake, the evidence that protracted low stages preceded the low stage of 1883 is conclusive. On the northeastern shore of the lake, close by the mouth of Mussel slough, there is a group of tree-stumps at an elevation of about 200 ft. These were found at the water's edge in 1882. They presented the appearance of having been broken off at a height of three to four feet above the ground. They were well preserved and must have been under water for nearly 30 years succeeding the high stage of the lake in 1853. These stumps are a remnant of a grove of willow trees, 100 or more, some of which had grown to a diameter of four feet."

The lands of the Fresno swamp have been practically all reclaimed by private efforts, but are still in danger from floods. The swamp land is a rich black vegetable mould, bordered by alkaline lands of little value extending above flood-level. Overflow lands bordering the San Joaquin farther north are unimportant and have been little studied. The map shows that lands are reported by the commission of 1873.

†Water Supply Paper No. 17, U. S. Geol. Survey.

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

It is an obvious and undisputed principle of swamp reclamation and flood protection that each drainage system must be treated as a unit. With water as scarce as it is in the upper San Joaquin valley, there is a great temptation to think the problem for the Tulare lake region solved by diverting flood flow to the San Joaquin river. But it is the plain duty of the state to see that nothing is done to complicate the already difficult problem of the lower San Joaquin. No political unit smaller than the state could handle such a problem, and there is no apparent reason why the national government should pay for the drainage of lands granted to the state on the understanding that they be drained. Even the problem of handling the floods of the San Joaquin river belongs purely to the state. There is no analogy to the Mississippi, as the whole course of the river lies within California, and there is practically no navigation above Stockton. Even aside from the obligation to protect these lands incurred by the state in accepting the grant of 1850, I know of no apparent reason why the people of the country at large should pay for the protection of California lands from a California river. Certainly the national government cannot be expected to drain the Tulare lake basin, and when this is drained, its surplus waters must pass through the lower San Joaquin to the sea.

The tidal marshes of Suisun, San Pablo, and Humboldt bays have all passed to private ownership, and have been, or are being, reclaimed. These problems are purely local, as there are no large streams opening through these lands, and existing laws and agencies are sufficient.

It is evident that the protection of lands from floods in California must be studied in two parts, the Sacramento system and the San Joaquin system. The Sacramento has been thoroughly studied, and the plan proposed by the Débris Commission provides thorough protection from floods at an estimated cost of $33,000,000. The Débris Commission reported that the saving to the general government through protection of the low-water navigation channel would justify the payment of one-third of this cost by the United States, but this has not yet been approved by Congress. No comprehensive study of the San Joaquin has ever been made, but Mr. Grunsky states‡ that in the San Joaquin valley south of Stockton there are 1950 square miles, or about 1,250,000 acres, of land subject to occasional floodings. Surely there is enough value to justify at least a thorough preliminary investigation by the legislature, through the state engineer or other competent agent.

‡Water Supply Paper No. 17.

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Collapsing Pressure of Steel Tubes*

By R. S. HASELTINE†

EXTERNAL collapsing pressure of oil-well casing is a subject concerning which there is apparently very little known in the oilfields. Every joint of casing sent to the oilfields is presumably tested to a certain internal pressure and the test pressure is plainly marked on the outside of the casing. It is assumed that the casing can be safely used while subjected to any internal pressure within this limit. This test is not so important to the oil-man who rarely, if ever, subjects the casing to an internal pressure approaching the test pressure. The point of interest to him is at what depth is it safe to shut off water with a certain sized casing.

A very thorough and exhaustive series of tests was made at the National Tube Works by Reid T. Stewart of Alleghany, Pennsylvania, and reported by him to the American Society of Mechanical Engineers in May 1906. This report will well repay a thorough study by those interested in the subject. For the purpose of this paper only a brief digest of the report will be given. To quote from the report: "This research was undertaken for the purpose of supplying an urgent demand for reliable information on the behavior of modern wrought tubes when subjected to fluid collapsing pressure. Every means known to engineering science that could aid in the accomplishment of this undertaking has been used, and every possible effort made to get at the truth and have the research yield trustworthy data. It was planned and executed under the immediate direction of the author of the McKeesport works of the National Tube Co., and has required for its completion a period of four years and the time of from one to six men.

The tubes were tested in a cast-steel cylinder fully described in the report, the essential features of the arrangement being the provision for the application of water under high pressure to the outside of the tube to be tested, gauges for accurately indicating the pressure on the tube throughout the test. Between 400 and 500 tubes were tested, these varying in outside diameter from 5 to 11 in. The tubes to be tested were selected at random from job orders coming from the mill, in order that results obtained would be representative of what might be expected in common practice. Each tube was weighed and the length and thickness carefully measured, also the variance from a true circle and outside diameter at each foot in length along the tube were carefully determined by an autographic calipering apparatus.

After each test the collapsed tube was photographed and the following exact measurements taken: (1) distance from point of collapse to end of tube;

*Paper read before Coalinga Oil Men's Association, March 16, 1911.
†General Manager, British Con. Oil Corpn., Ltd., Coalinga, California.

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

(2) relation of axis of collapse to smallest diameter of tube; (3) relation of axis of collapse to weld in tube; (4) relation of axis of collapse to thinnest portion of wall.

The first 122 tests were made on tubes 2½, 5, 15, and 20 ft. in length, to determine the influence of length of tube on the collapsing pressure. A study of the results obtained shows conclusively that the longer the tube the less collapsing pressure it is able to withstand, but the difference is very slight between a length of 20 ft. and a length equivalent to six times the diameter of the tube. Lengths shorter than 6 diameters, however, were very much stronger, an 8¼-in. nipple 2 ft. long requiring 400 lb. more pressure to collapse it than a nipple 5 ft. long.

The result of the tests showed that by far the greater number of tubes collapsed at a point within 2½ ft. of the end of the tube. In regard to this, Mr. Stewart says: "The reason the bulk of these tubes collapsed near one end is evidently due chiefly to the fact that a tube subjected to a collapsing pressure is weakest where the departure from roundness is greatest, even when this is small, and that the greatest departure from roundness for the bulk of these tubes was near one end."

It was shown plainly by autographic calipering apparatus that none of the tubes tested was exactly round. This departure from roundness was small, the diameters of the tube at any one place varying not over 2%. However, the results of the tests plainly show that the slight 'out-of-roundness' was the chief factor in determining the place of collapse.

Regarding the weld in the casing, the results obtained in the tests showed "that the angular distance from the weld to the axis of collapse is quite uniformly distributed and that the weld itself is not an element of weakness for tubes that are subjected to external fluid pressure." The thinnest portion of the wall was found to have some influence on the axis of collapse, it being found that the tendency of the tube was to collapse at right angles to the diameter through the thinnest portion of the tube. This influence was not nearly so strong as that occasioned by the 'out-of-roundness' of the tube.

From the results of these experiments Mr. Stewart has deduced the following formula which is applicable to all California oil-well casing of 10 in. inside diameter or smaller:

$$P = 86670 \frac{t}{d} - 1386$$

Where P = collapsing pressure in lb. per square inch
t = thickness of wall in inches
d = outside diameter of tube in inches

For casing of larger diameters or thinner walls, where $\frac{t}{d}$ is less than 0.023, the following formula is applicable:

$$P = 1000 \left(1 - \sqrt{1 - 1600 \frac{t^2}{d^2}}\right)$$

Where P, t, and d are the same as for first formula.

In all tests made, not one tube failed at a pressure 43% less than that calculated by the formula and less than 3% of the tubes tested failed at a pressure 25% less than the calculated pressure. In other words, with an actual factor of safety of 1.75, not a single tube failed. In this regard Mr. Stewart says: "Under the most favorable conditions, a factor of safety of 3 would seem sufficient. When only a moderate amount of loss could result from failure, use a factor of 4, and when con-

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

siderable damage to property and loss of life might result from failure, use a factor of safety of at least 6."

In oil-well work, the casing is subjected to external collapsing pressure when the fluid outside the casing stands higher than the fluid inside the casing and the difference in the height of these two columns is the height of the column of fluid tending to collapse the casing. In the life of the well the most severe test on the casing occurs when the water has been shut off and the hole is bailed dry to test the job. The extreme pressure then is not necessarily equivalent to a water column as deep as the hole, for in very few instances does the water behind the casing stand as high as the top of the hole. The height of the normal level, above the bottom of the hole at the point where the water is shut off, is the height of the column of water subjecting the bottom of the casing to collapsing pressure when the hole is bailed dry. This extreme test usually occurs but once in the life of a well, there being some fluid inside the casing at subsequent times, offsetting the external pressure.

There is some doubt in my mind as to the advisability of offering for general use a table in which tabulated results are computed by using a factor of safety of 2 only, but it is already quite common practice in California oil-well drilling to shut off water and bail the hole dry at a greater depth than a factor of safety of 3 would allow. The following table, therefore, is offered with the belief that the figures in the last column can be safely used, providing that the string of casing which is to be exposed to pressure has not been subjected to hard usage and, particularly, that the lower joints have not been excessively worn by tools and line.

The table has been computed from the formulae above mentioned, using the thickness and diameters as given in the catalogue of the National Tube Co. for California special oil-well casing. As the casing manufactured by different concerns often varies somewhat from the figures herewith given for thickness and diameter, it would be well to take these measurements carefully on casing with which it is intended to shut off a column of water approaching the height allowed in the last column of the table. Should these measurements be found to vary appreciably from those given in the table, the collapsing pressure of the casing can readily be calculated by use of the formula as given above.

TABLE SHOWING COLLAPSING PRESSURES OF LAP-WELDED STEEL CASING FOR SIZES COMMONLY USED IN CALIFORNIA.

Size, Inches	Weight per Foot, pounds	Inside Diameter, inches	Outside Diameter, inches	Thickness, inches.	Collapsing Pressure, pounds per square inch	Equivalent Water Column, feet ...	Water Column Factor of Safety 2, feet .....
4½	15.0	4.500	5.000	0.250	2944	6790	3395
5⅝	20.0	5.370	6.000	0.315	3160	7280	3640
6¼	20.0	6.000	6.625	0.312	2704	6230	3115
	26.0	5.845	6.625	0.390	3717	8560	4280
	28.0	5.775	6.625	0.425	4167	9600	4800
6⅝	20.0	6.437	7.000	0.281	2096	4830	2415
	26.0	6.312	7.000	0.344	2867	6600	3300
	28.0	6.220	7.000	0.390	3440	7930	3965
7⅝	26.0	7.390	8.000	0.305	1914	4410	2205
8¼	28.0	8.015	8.625	0.305	1680	3870	1935
	32.0	7.935	8.625	0.345	2080	4790	2395
	36.0	7.875	8.625	0.375	2383	5490	2745
	38.0	7.765	8.625	0.430	2928	6750	3375
	43.0	7.625	8.625	0.500	3638	8380	4190
9⅝	33.0	9.500	10.000	0.250	780	1800	900
10	40.0	10.000	10.750	0.375	1638	3770	1885
	48.0	9.850	10.750	0.450	2234	5150	2575
	54.0	9.750	10.750	0.500	2643	6090	3045
11⅝	40.0	11.437	12.000	0.281	641	1475	737
12½	40.0	12.500	13.000	0.250	402	927	463
	45.0	12.360	13.000	0.320	745	1717	858
	50.0	12.250	13.000	0.375	1109	2560	1280
13½	50.0	13.250	14.000	0.375	936	2160	1080
15½	51.3	15.416	16.000	0.292	314	724	362

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Speed of Water-Wheel Runners

By ELY C. HUTCHINSON

RATIO between the full load or normal operating peripheral speed of either Francis turbine or tangential water-wheel runners, and the theoretical spouting velocity of the water for any given head and operating speed within the ranges shown, may be determined by chart 1. When used in conjunction with chart 2, the maximum theoretical runaway speed of the runner in percentage above normal, friction and windage neglected, may be quickly ascertained.

The use of the charts may best be illustrated by example as follows:

To find, referring to chart 1,

1. The ratio in percentage between the peripheral speed and theoretical spouting velocity; and also
2. The maximum runaway speed in percentage above normal for the following conditions:
   - *a* 28-in. diam. runner,
   - *b* effective head 280 feet,
   - *c* normal or full-load speed of runner 880 r.p.m.

Follow the 280-ft. head ordinate upward to the intersection of the curved line marked '28-in. runner diameter.' Then follow the co-intersecting abscissa to the right where it meets the diagonal line marked '1100.' This last figure will be found to coincide with the speed in revolutions per minute which would result if the runner were to operate at 100% of the theoretical spouting velocity of the water, that is, maximum theoretical runaway speed. Follow the diagonal downward until it intersects the abscissa for 880 r.p.m. Trace downward from this point to the co-intersecting ordinate which represents the percentage ratio between normal peripheral

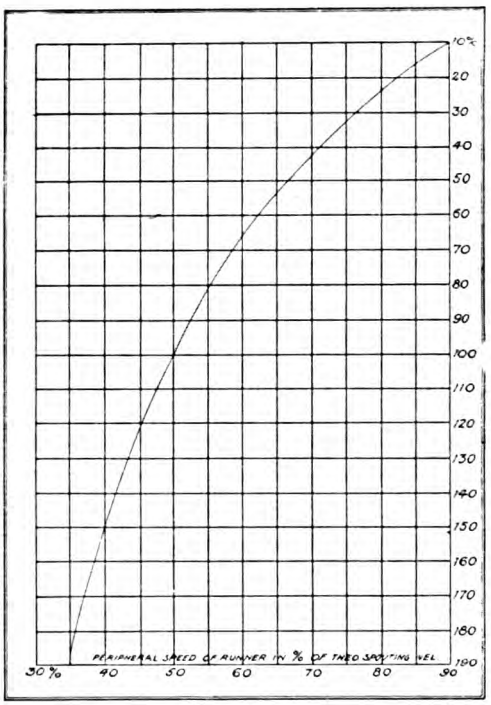


CHART No. 2.

speed and theoretical spouting velocity. In this particular case the value is found to be 80 per cent.

The maximum theoretical runaway speed in percentage above normal may be found by reference to chart 2, as follows:

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Read upward in the ordinate marked 80% to its intersection with the curved line, thence horizontally and to the right on the co-intersecting abscissa where the required value is 25%. A further study of the two charts will develop a variety of purposes to which they may be advantageously applied.

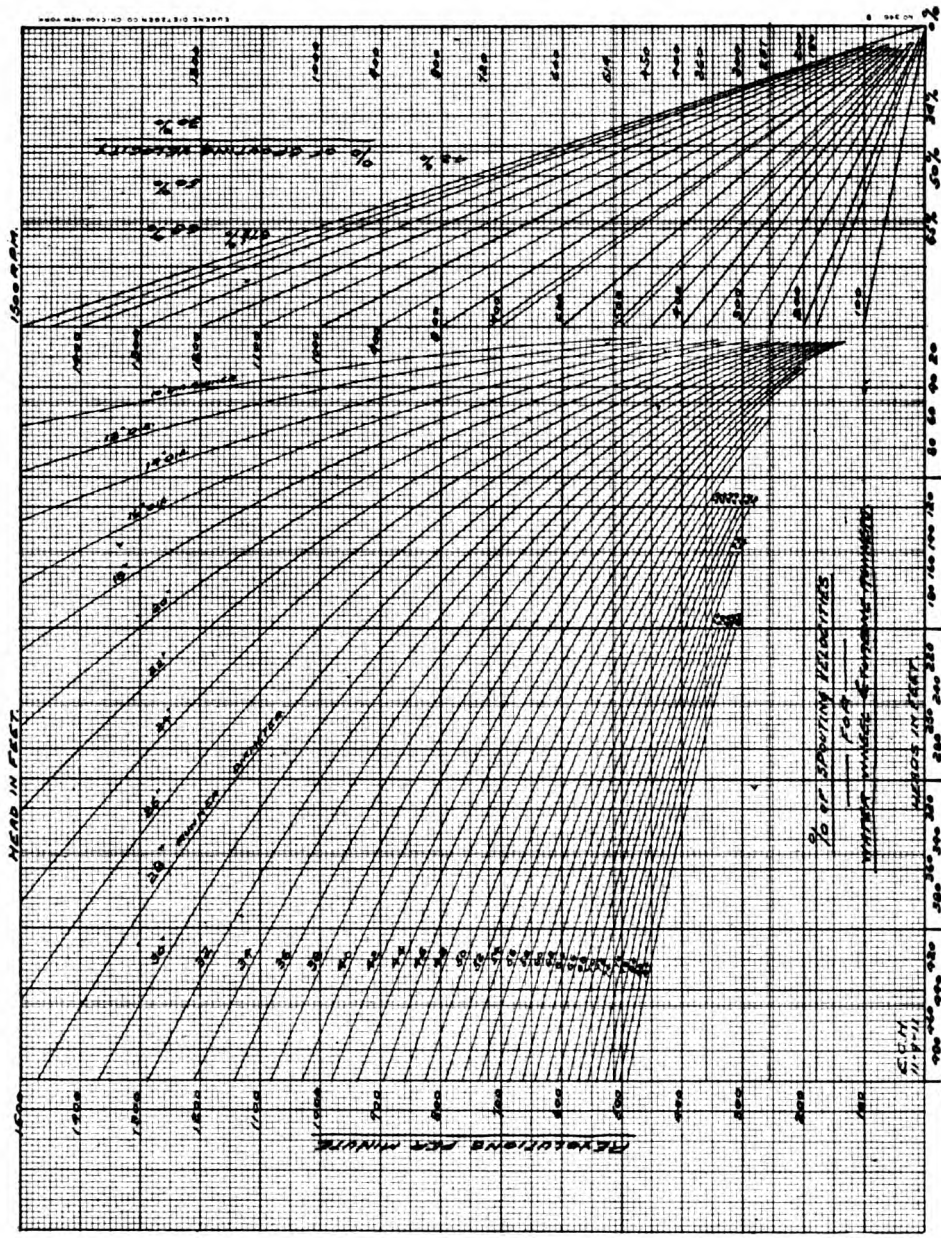


CHART No. 1.

Generated on 2024-09-29 23:48 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Extinguishing a Burning Gusher

By E. A. FLANDERS*

BURNING of the Pacific Crude Oil Co.'s gusher in the Midway oil-fields near Taft, California, furnishes an example of the danger from fire in an oil-producing territory, and also of the manner in which oil producers co-operate in fighting a common enemy.

The Pacific Crude Oil Co.'s well came in on May 30, and was under control. The rush of oil, carrying with it sand and gravel, cut the fittings controlling it in a short time, and the well broke loose, the column of oil rising above the crown block of the derrick and soaking everything within a quarter-mile radius. At the present time the well is producing about 9000 barrels per day, while at the time of the fire it was estimated that the production was about 12,000 barrels. Sunday afternoon, June 2, a fire started in the engine-house of the Buick rig, about 150 yards from the Pacific Crude gusher. There was no engine in the house, and the source of the fire remains a mystery. It was probably started by the carelessness of some workman stealing a smoke. Between the Buick and the Pacific Crude wells were two sumps, each containing oil. The Buick men coupled on their hose and succeeded in driving the fire from their well. The oil-soaked grass caught fire, and the flames swept toward the Buick camp, and soon, in spite of all efforts, the camp was only a memory. About this time the oil in the Buick sump blazed up, and the wind rolled the fire

THE BURNING WELL.
(Clendenon photo.)

*Taft, California.

Generated on 2024-09-29 23:47 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

across the two sumps toward the Pacific Crude well. The derrick blazed, and then came a peculiar freak of the fire. It was some minutes before the column of oil and gas in the centre of the rig ignited. The flames played up and down the bailer, which was hanging in the rig, seemingly ignoring the highly inflammable stream of oil. However, in a very short time the oil ignited with a roar, and a veritable pillar of flame shot skyward.

To one who has never seen a burning gusher, the task of putting it out would seem an impossibility. To an experienced oil-man, fighting a fire is a nightmare awake, and work is full of danger and endless discouragement. Harry Becker, superintendent for the Pacific Crude company, immediately started to work. With the resources of his own company and those of his neighbors, he had at his disposal twenty picked men and a battery of eighteen boilers: 4 forties from the Alaska Pioneer, 4 seventies and 2 forties from the Buick, 2 seventies and 1 forty from the California Midway, 3 forties from the Associated, and 2 forties from his own lease. Two belt-lines, one water and one steam, were laid around the well with a radius of about 250 ft. Twelve water jets were arranged to throw water on the red-hot metal, rig irons, pipe, etc., in the vicinity of the well. This metal had to be cooled in order that the well once out would not again be ignited. Five steam lines were prepared to run from the belt-line to the well. These lines were of 2-in. pipe, with the end joint hammered down to form a nozzle. When all was ready the dangerous work of placing the jets began. Four of the steam jets were used to play at the base of the flame and one to sweep the ground free of burning oil. At first, shields covered with asbestos were used. These had to be discarded because they interfered with the work, and, in spite of the asbestos protection, caught fire. When that method failed, another was adopted. The second relied entirely on the sheer speed and courage of the fighters. The nozzle end of the line was put on wheels and the men distributed along its length. At a given signal, the line was picked up and a rush made to place it. The heat was so intense that during this operation the men were forced to hold their breath. All work was done at night, as during the day no one could approach the well without being overcome. During the week of the fire the weather was very hot.

The débris around the well added to the difficulty of placing the jets properly, but grit and perseverance finally succeeded, and all the jets were in position and coupled up. In turning on the steam, advantage was taken of the fluctuating gas-pressure in the well. When the flow decreased, the steam was turned on. The flame would flicker and die down and then take fresh hold and a great balloon of flame would rise, sometimes accompanied by great smoke rings. Then the steam would be turned off to gather head for another attempt. The well was out four times, once for six minutes, only to blaze up again. Finally, at 10 p.m. Thursday, the flame was snuffed out for the last time. The burning oil in the air fell to the ground and was swept down a little gully, the wind, water and steam rolling the flames away from the well. Oil dropping from the gusher added fuel to this fire. Suddenly the wind changed and the spray of oil gushed the other way. The well was safe. The following Sunday the well was successfully capped, and all worries were over.

Generated on 2024-09-29 23:47 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The Engineering Digest

The Fuel Economizer*

By T. F. J. MAGUIRE

IN any boiler installation, the gases of combustion given off by the furnace pass over the heating surface of the boiler; and by so doing, more or less of the heat contained by the gases is transmitted to the water contained in the boiler, thereby generating steam and creating heat energy in a form suitable for commercial purposes. The temperature of the gases of combustion is at its maximum just before the gases reach the heating surface; the gas temperature decreases, until it reaches a minimum value where it leaves the heating surface and escapes from the boiler enclosure. The process of combustion is practically completed before the heating surface is reached, as the abstraction of heat is then so rapid that there is but small chance for a continuation of the process. However, a certain amount of combustion may take place while the gases are passing over the heating surface and up to the point where the gas temperature falls to 1200 or 1300° Fahrenheit.

The heat transmitted by any element of the heating surface of the boiler depends upon the temperature of the gases passing over the element, and the temperature of the steam and water contained by the boiler. As the latter temperature is practically the same throughout the entire heating surface, and as the temperature of the gases is a maximum just where the gases first impinge upon the heating surface, it follows that the nearer a given element of the surface is to the furnace, the more heat it will transmit. For equal areas of heating surface there is a difference in the amount of heat that will be transmitted, depending upon their relative positions along the path of the gases of combustion. In boilers, especially those of the water-tube type, it is probable that the first tenth part of the heating surface transmits 60% or more of the total heat delivered to the water, in any given time, and that the last tenth part gives but 1%, with the boiler operating at or near its rated capacity. In other words, the first tenth part of the heating surface does about 60 times as much work in a given time as the last tenth part. The farther a given heating area is from the furnace, along the path of the gases of combustion, the less will be the heat that it will transmit, and therefore the less valuable it will be as an element of the boiler. It is therefore evident that there is a limit to the extent of heating surface to use for any given size of boiler, and that this limit is reached when the additional cost of the boiler due to the added heating surface is not warranted by the decrease in the temperature of the gases.

For any given steam pressure at which the boiler operates, there is a definite temperature for the steam and water contained by the boiler; and as the temperature of the gases must always exceed the temperature of the steam and water, in order to enable heat to be transmitted, it is evident that it would take an indefinitely large heating surface, for any given size of boiler, to lower the gas temperature approximately to the temperature corresponding to the steam pressure. As a matter of acual practice, a boiler equipment is operating at good economy if, at rated capacity, the temperature

*Abstract from *The Engineering Magazine*, June 1912.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

of the gases escaping from the enclosure is 100°F. in excess of the temperature corresponding to the steam pressure. As an illustration, a boiler operating at rating, at 150-lb. gauge pressure, corresponding to a temperature of 365°F., would not, under good operating conditions, cut the temperature of the gases below 465° Fahrenheit.

The maximum amount of heat that can be taken from the gases of combustion is the difference between the heat contained in them at the furnace temperature and the temperature of the surrounding air. With the apparatus now in practical use, it is impossible to reach anywhere near the lower temperature limit, and indeed the practical limit is far above it. To illustrate, the magnitude of the heat in the gases after they escape from the boiler, with a temperature of 70°F. for the surrounding air, a furnace temperature of 2400°F., and a breeching temperature of 465°F., 17% of the available heat is lost, so far as the boiler is concerned. Of course, it is not practicable to save all of this loss, but enough of it may be recovered to make it an economical proposition, in many power-plants, to install apparatus for the purpose.

The equipment used is known as a fuel economizer, and it consists of sets of straight vertical tubes, fitted top and bottom into suitable headers, the latter in turn being connected to longitudinal pipes or boxes for the proper distribution of the water to the economizer sections and for connecting the economizer to external piping. The whole is enclosed in a brick setting, a chamber being generally provided below the sections for taking care of the soot and ashes. The economizer is connected in the feed line supplying water to the boilers, usually between pumps and boilers, and is therefore operating at boiler pressure. The economizer enclosure is connected to the boiler breeching at one end, and at the other to the stack, or, if fans are used, to the suction inlet of the fans. In order to permit of taking the economizer out of service for cleaning or repairs, it is customary to by-pass the economizer by a suitable breeching connection, and of course a similar by-pass arrangement should be made for the water.

A stack alone (natural draft) is often not a practicable project for an installation employing economizers, on account of the excessive stack height that would be required; and in many other cases where the stack is feasible, it is not as economical as a mechanical equipment. Where a system of forced mechanical draft is used, it may happen that a stack will be more desirable than induced mechanical draft, in conjunction with an economizer, but in the greater number of cases it is believed that the induced mechanical-draft equipment will prove the more economical investment.

On account of the comparatively low temperature of the gases passing over the heating surface of an economizer, it is essential, from economic considerations, to keep the heating surface as clean as possible. For this reason a scraper is provided for each tube, and the scrapers are continually in motion up and down the tubes while the economizer is in service, the scraper mechanism being operated by an electric motor or some other driving mechanism suitable to the plant conditions.

The flow of water through the conomizer is in a direction opposite to the flow of the gases, thus putting the coldest water nearest the gases just as the latter are about to escape from the economizer setting. With this arrangement, and for a given amount of heating surface, the maximum amount of heat is transmitted and consequently the best operating economy is obtained. Unequal temperature strains are minimized and the tendency to rupture of the parts is diminished, which is particularly important, as all parts of an economizer are made of cast iron.

While the economizer has certain other advantages, the principal reason for its use is that it saves enough in fuel to justify it. Just what it saves in fuel for any given plant may be readily estimated. Any assumed boiler plant is supposed to develop, on the average, a certain number of pounds of steam per hour at a certain boiler pressure. The less the temperature of the feed water entering the boiler, the more heat will be required to do the boiler work, and consequently the greater the amount of coal burned. Assume that the plant under consideration generates on the average W pounds of steam per hour at a gauge pressure of P pounds; and, for simplicity, that the steam is dry saturated steam. If the fuel used has an evaporative power at the average boiler load equal to E_a pounds of water from and at 212°F. per pound of dry fuel,

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN

and the average temperature of the feed water is t_f, then the average dry fuel burned per hour, w, as follows:

$$w = \frac{W}{E_a} \times \frac{Q + 32 - t_f}{965.7} \text{ lb.}$$

in which Q equals the heat in a pound of steam at 32°F. As an illustration, take the case of a certain boiler plant operating at 150 lb. steam-pressure, and assume that the feed-water temperature, without the economizer in use, is 80°F., and with the economizer in use is 260°F., under average load conditions. For these conditions the economizer would show an average saving of about 16% of the coal. If the feed water delivered to the economizer had a temperature of 160°F. and in leaving the economizer had a temperature of 300°F., then the saving in coal would amount to 13%. For any given installation the saving made by the economizer is dependent upon the temperature of the water entering the economizer; and the higher the temperature is, the less will be the gain, other conditions being the same.

The capacity at which a boiler may be driven depends upon the rate at which the fuel can be burned, or upon the number of pounds of fuel that can be consumed in a given time. If, in any given plant, a certain amount of coal can be burned per hour, it is evident that the higher the temperature of the feed water entering the boilers, the more steam will be developed by the boilers at the operating pressure. As the economizer increases the feed-water temperature, the output of the boilers in pounds of steam per hour is increased by the use of this apparatus. In other words, the capacity of the boilers is increased by the action of the economizer in raising the temperature of the feed water, and consequently a greater overload may be carried. For a given amount of coal consumed per hour, with or without economizer, the horse-power output of the boilers would be the same, but the amount of steam actually generated at the operating pressure would be greater with the economizer in use than without it. In a plant operating at 150 lb. gauge pressure, with feed water at 80°F. without economizer and at 260°F. with it, the capacity of the boilers will be increased about 19 per cent.

The use of an economizer will very often increase the operating safety of a boiler and will in addition enable the boilers to run for longer periods before it is necessary to take them out of service for cleaning. The water capacity of an economizer is usually sufficiently large to cause the water flowing through it to move at a relatively low velocity, thereby permitting solid matter held in suspension to be precipitated. A considerable portion of the mud, clay, sand, etc, present in the feed water will be deposited in the economizer, with a resulting gain in the reliability and economy of the boilers.

Water used for boiler-feed purposes nearly always contains compounds that tend to form objectionable scale in boilers. These compounds are held in solution in comparatively cold water, but are thrown out of solution when the temperature of the water is raised above a certain point. The most common scale-forming compounds are the carbonates and sulphates of calcium and magnesium. Most of the carbonates are thrown out of solution when the water is raised to a temperature of about 200°F., but the sulphates are held in solution until a temperature of 300°F. or more is reached, and indeed are fully deposited only upon concentration by evaporation. The carbonate of calcium forms a loose porous scale and is not objectionable in itself, except when present in large quantities. The magnesium carbonate and the sulphates, however, form a hard, cement-like scale that is decidedly objectionable from both safety and economical considerations.

While it is necessary to raise the feed-water temperature to the temperature given above, in order to cause a precipitation of the scale-forming compounds out of solution, it is equally essential to provide sufficient volume, in such apparatus as fuel economizers and open and closed heaters, to enable these impurities to settle; otherwise they will be carried in a suspended form into the boilers. Insufficient water capacity is very often the cause of the failure of exhaust and live-steam heaters to eliminate to any appreciable extent these scale-forming compounds. The initial and final temperatures of the feed water in the economizer have an important bearing upon the value of the economizer as a purifier. The lower the temperature of the incoming water, the greater will be the volume of the economizer through which the water passes before it attains the necessary temperature to precipitate the scale-forming compounds, and

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

therefore the less will be the time left for this precipitation. As the carbonates are thrown out of solution, for the most part, at about 100°F. lower temperature than the sulphates, it follows that most of the scale-forming compounds caught in an economizer are carbonate, and that in general but little of the sulphates are precipitated. This is especially due to the fact that even if an economizer raises the feed water to a point considerably in excess of 300°F. at the outlet, the economizer volume left for the water to travel through is too small to permit the precipitation of the sulphates. While an economizer, especially in conjunction with a feed-water heater, can be of good service in clearing the water of sand, silt, and certain carbonates, it is doubtful if it has large value in getting rid of the more troublesome sulphates of calcium and magnesium. The higher the initial and final temperature of the water in the economizer, the more valuable it will be as a purifier; and for this reason a combination of exhaust-steam feed-water heater and fuel economizer gives good results if of sufficient capacities, the heater, in such an arrangement, increasing the effect of the economizer by supplying the latter with water at as high a temperature as is consistent with the other plant conditions.

The repair item for an economizer depends to a considerable extent upon the manner in which it is operated and the piping arrangements used with it. As the economizer is under boiler pressure, care must be taken not to lower the pressure on the economizer suddenly, as there is usually enough heat in the water contained therein to generate steam, with the result of a more or less vicious water hammer. It is advisable not to tap the feed line from the economizer for hose connections or to fill an empty boiler from it. Special care must also be taken in blowing down an economizer when under pressure. To avoid serious damage, the feed pump must be kept running to avoid emptying or partly emptying the economizer. Broken parts or sections might be caused by pumping cold water into the economizer while it is empty and hot.

The real value of an economizer depends upon the saving made in the cost of fuel, and the latter evidently depends upon the cost per ton of the fuel, the relative value of the average load on the plant to the full load, and the hours of plant operation. Other things being equal, the higher the cost of the fuel per ton, the more valuable will be the economizer as an investment, and the same will also be true the higher the average load factor and the greater the time of plant operation.

In general, it is probable that an induced mechanical-draft equipment with a fuel economizer will show an increased economy over a stack alone or natural draft. Even with a forced-draft system for the furnace, a stack, as compared to the induced-draft equipment, will seldom show to advantage economically. For these reasons it is a common practice to install an induced mechanical draft equipment with economizers.

The fuel economizer in general increases the operating economy of a plant by abstracting heat from the gases given off by the boilers. The economizer also consumes a certain amount of energy for driving the scraper mechanism. There are many contemplated installations where natural draft or a stack would be adapted if no economizers were to be installed, and for such plants the proper comparison would be made between the stack and the economizer with induced-draft equipment. The following example will illustrate a comparison between a stack and an induced-draft equipment and economizer. In what follows, the various assumptions made as to life of equipment, economy of operation, fuel chargeable to mechanical apparatus, etc., are values taken for the specific purpose of showing a comparative economy of the two equipments for the particular plant considered, and of course such figures are liable to considerable variation for any actual plant—as well as the result deduced from these assumptions.

A certain plant consists of four 125-hp., 72-in. by 16-ft. return-tubular boilers designed for a working pressure of 125 lb. gauge, each boiler being equipped with 27 sq. ft. of grate area. The fuel to be used at the plant is a good grade of bituminous coal capable of evaporating 9 lb. of water from and at 212°F. per pound of coal with the boiler equipment operating at or near rating. The boiler plant is to be capable of operating for certain intervals at an overload of 25%. At 25% overload, with the above coal, the rate of combustion would equal about 23 lb. of dry coal per sq. ft. of grate per hour. Allowing 0.20 in. of draft for furnace at 25% overload, 0.20 in.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

of draft for loss in boiler setting, and 0.15 in. loss for breeching, the maximum draft required of a stack (without economizer) for this plant is 0.55 in. of water column, and the required stack for this plant would be 50 in. diameter and 100 ft. in height above the grates. A guyed steel stack of the above size would cost about $600.

Consider the substitution of an economizer and a suitable induced mechanical-draft equipment for the stack noted above, and assume that the average load on the plant is equal to the rated capacity of the boilers of 500 hp. Allowing 4 sq. ft. of surface per boiler-horsepower, the economizer will have a total heating surface of 2000 sq. ft., and the fan of the draft equipment will have to handle, at 25% overload, about 15,300 cu. ft. of gases at about 300°F. and develop at this output a draft intensity equivalent to 0.80 in. of water column—0.25 in. additional draft loss allowed in economizer and connections. A 60-in. fan, operating at about 320 r.p.m. maximum, will be required, and the fan system should be in duplicate to equal the reliability of the stack noted above. It is estimated that the economizer and duplicate fan equipment will cost, for this plant, $3300. The comparison of the two installations for this plant would consist of a 50-in. by 100-ft. stack (cost $600) on one side, and on the other a 2000-sq. ft. economizer and two 60-in. fan outfits (cost $3300).

With an average load of 500 hp. on the four 125-hp. boilers, the temperature of the gases escaping from the boilers may be assumed at 500°F. and the gas temperature at the outlet of the economizer at 270°F., the corresponding increase in the feed-water temperature, due to the economizer, being assumed at 140°F. If the boilers are operating at 125 lb. steam pressure and the feed water entering the economizer is 100°F., then the saving in coal due to the economizer is equal to 12.5% for equal steam output of the boilers under the two different feed-water temperature conditions. The coal consumed to operate the induced fan equipment and tube scrapers may be taken at 2% of the total coal consumed with stack, in which case the combined outfit of economizer and fans would save, for the plant in question, about 10.5% over the stack.

The repair and maintenance item for the 50-in. by 100-ft. stack would consist simply of the cost of painting the stack once a year at a price of about $25. The same item for the fan and economizer installation would cover the cost of all repairs to fans and economizer as well as that of gaskets, packing, lubricating oils, etc. It would not be unreasonable, for the plant in question, to assume an average repair and maintenance item for fans and economizer of not less than $75 per year.

If the plant operates 12 hours per day and 6 days a week, and coal is worth $2.50 per ton delivered in front of boilers, then the economizer and induced fan equipment will save $992 per year in coal (5% moisture assumed for coal) over the stack. If a life of 10 years is assumed for both equipments and an interest charge of 5% is taken for depreciation and interest charges on the investments, then the annual interest and depreciation charges for the stack will amount to $78 and for the economizer and fan equipment $428. Allowing for the saving in fuel due to the use of the economizer and induced-draft equipment, the total annual saving due to the economizer over the stack is $592.

The mistake is very often made, in estimating the profit due to an economizer equipment over a plain stack, of assuming that the yearly profit is equal to the gross saving in coal due to the increase in the temperature of the feed water as brought about by the economizer, no account being taken of such important items as maintenance and repair, interest and depreciation on investment, etc. All of these latter items are almost always favorable to a stack, and hence such a method of comparison is decidedly incorrect and misleading. In the example taken above, the annual gross saving in coal was $1181, while the actual saving, taking into consideration all items, was $592, or practically one-half of the former.

In favor of the economizer, it must be observed that for large installations such as central stations and traction power-plants, other and generally controlling arguments for the stoker installation come into play. In such a station it would no doubt be the practice to install stoker equipments, driving the boilers continuously at the rate of a boiler-horsepower for 5 sq. ft. of boiler surface or even less, instead of the approximately 8½ sq. ft. assumed in the example above. The 3½ sq. ft. of surface thus cut

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

off from the boiler might be replaced by 1½ to 2 sq. ft. of economizer surface, preserving the same final temperature and over-all efficiency. As boiler surface installed costs about $2 per sq. ft., and economizer surface installed but $1.20 per sq. ft., approximately, there would be a gain in economy of installation.

The comparison carried out in this article, however, is intended for small plants, not for large stations, and in a relatively small installation such as chosen above, consisting of four 125-hp. boilers, the real value of the argument last stated becomes doubtful. Considerable variations of the values assumed for cost of coal, depreciation, coal used by fan and scraper, etc., must of course be expected and allowed for in considering any specific plant.

There is no question but that the fuel economizer is a valuable piece of apparatus for boiler installations in general; but just how valuable it is depends of course upon many items of plant design and operation. No general rule is applicable, and the gross saving in coal per year is not the proper criterion to go upon. Under favorable conditions, an economizer equipment increases the operating economy of the plant, increases the maximum output of boilers for the same rate of fuel combustion, maintains the interior of the boilers in a cleaner condition, and hence permits longer intervals, generally, between cleaning, and provides a comparatively large amount of hot feed-water for emergency use. This last advantage is quite important, especially in plants where a sudden and large increase in the load is likely to occur in a comparatively short interval of time. But, like any other engineering equipment, an economizer installation must be intelligently installed and operated to secure the savings possible from its use.

Tons of Stone Per Mile Required to Build Roads*

FOR the information of intending road-builders, the following tables, which approximate the number of tons of thoroughly rolled stone necessary to construct each mile at the designated depths and widths, have been compiled. The basis is 3000 tons of loose stone or 3500 tons of compressed stone for a road one mile long, 16 ft. wide, and 8 in. deep. A road 8 in. deep, when finished, will have required at least 10 in. of stone. It should be placed in two layers of 5 in. each, and each layer rolled down to 4 in. Then the application of the ¾-in. rock and screenings will bring the road to the prescribed depth; for other thickness, the stone should be placed in proportion to the intended finished depths. An observance of this rule will insure the contract thickness for the roadbed, and save the sometimes necessary expense of surfacing before acceptance from the contractor.

Width in Feet.	Depth, Inches.	Tons of Stono per Mile.
8	4	875
8	6	1312½
8	8	1750
8	10	2187½
8	12	2625
9	4	984⅜
9	6	1476 9/16
9	8	1968¾
9	10	2460 15/16
9	12	2953⅛
10	4	1093¾
10	6	1640⅝
10	8	2187½
10	10	2734⅜
10	12	3281¼
11	4	1203⅛
11	6	1804 11/16
11	8	2406¼
11	10	3007 13/16
11	12	3609⅜
12	4	1312½
12	6	1968¾
12	8	2625
12	10	3281¼
12	12	3937½
13	4	1421⅞
13	6	2132 13/16
13	8	2843¾
13	10	3554 11/16
13	12	4265⅝
14	4	1531¼

*From report of Commissioner of Public Roads, New Jersey.

Generated on 2024-09-29 23:49 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Width in Feet.	Depth, Inches.	Tons of Stone per Mile.
14	6	2296⅞
14	8	3062½
14	10	3828⅛
14	12	4593¾
15	4	1640⅝
15	6	2460 15/16
15	8	3281¼
15	10	4101 9/16
15	12	4921⅞
16	4	1750
16	6	2625
16	8	3500
16	10	4375
16	12	5250
17	4	1859⅜
17	6	2789 1/16
17	8	3718¾
17	10	4648 7/16
17	12	5578⅛
18	4	1968¾
18	6	2953⅛
18	8	3937½
18	10	4921⅞
18	12	5906¼
19	4	2078⅛
19	6	3117 3/16
19	8	4156¼
19	10	5195 5/16
19	12	6234⅜
20	4	2187½
20	6	3281¼
20	8	4375
20	10	5468¾
20	12	6562½

As many persons interested in the construction of stone roads are asking questions about their cost, the table below has been compiled to show at a glance the number of square yards at different widths in a mile of road; also the cost at different widths, and various prices per square yard. Any variations from these prices can be quickly ascertained by adding, subtracting, multiplying, and dividing for a less or greater width. For example, a road 8 ft. wide has 4693⅓ sq. yd. in one mile. To obtain the number of square yards in a road having a width of 9 ft., add ⅛ to the foregoing figures, and in one having a width of 7 ft., subtract ⅛; in one twice the width given in the table, multiply by two.

Much additional data on this subject has been compiled by the New Jersey Department of Public Roads and published in the report of the Commissioner.

Width in Ft.	Sq. Yd. per Mile.	Cost per Yd., Cents.	Cost per Mile.
8	4,693⅓	25	$1,173.33⅓
10	5,866⅔	25	1,466.66⅔
12	7,040	25	1,760.00
14	8,213⅓	25	2,053.33⅓
16	9,386⅔	25	2,346.66⅔
18	10,560	25	2,640.00
8	4,693⅓	30	1,408.00
10	5,866⅔	30	1,760.00
12	7,040	30	2,112.00
14	8,213⅓	30	2,464.00
16	9,386⅔	30	2,816.00
18	10,560	30	3,168.00
8	4,693⅓	35	1,642.66⅔
10	5,866⅔	35	2,053.33⅓
12	7,040	35	2,464.00
14	8,213⅓	35	2,874.66⅔
16	9,386⅔	35	3,285.33⅓
18	10,560	35	3,696.00
8	4,693⅓	40	1,877.33⅓
10	5,866⅔	40	2,346.66⅔
12	7,040	40	2,816.00
14	8,213⅓	40	3,285.33⅓
16	9,386⅔	40	3,754.66⅔
18	10,560	40	4,224.00
8	4,693⅓	45	2,112.00
10	5,866⅔	45	2,640.00
12	7,040	45	3,168.00
14	8,213⅓	45	3,696.00
16	9,386⅔	45	4,224.00
18	10,560	45	4,752.00
8	4,693⅓	50	2,346.66⅔
10	5,866⅔	50	2,933.33⅓
12	7,040	50	3,520.00
14	8,213⅓	50	4,106.66⅔
16	9,386⅔	50	4,693.33⅓
18	10,560	50	5,280.00
8	4,693⅓	55	2,581.33⅓
10	5,866⅔	55	3,226.66⅔
12	7,040	55	3,872.00
14	8,213⅓	55	4,517.33⅓
16	9,386⅔	55	5,162.66⅔
18	10,560	55	5,808.00
8	4,693⅓	60	2,816.00
10	5,866⅔	60	3,520.00
12	7,040	60	4,224.00
14	8,213⅓	60	4,928.00
16	9,386⅔	60	5,632.00
18	10,560	60	6,336.00
8	4,693⅓	65	3,050.66⅔
10	5,866⅔	65	3,813.33⅓
12	7,040	65	4,576.00
14	8,213⅓	65	5,338.66⅔
16	9,386⅔	65	6,101.33⅓
18	10,560	65	6,864.00

Generated on 2024-09-29 23:41 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Width in Ft.	Sq. Yd. per Mile.	Cost per Yd., Cents.	Cost per Mile.
8	4,693⅓	70	3,285.33⅓
10	5,866⅔	70	4,106.66⅔
12	7,040	70	4,928.00
14	8,213⅓	70	5,749.33⅓
16	9,386⅔	70	6,570.66⅔
18	10,560	70	7,392.00
8	4,693⅓	80	3,754.66⅔
10	5,866⅔	80	4,693.33⅓
12	7,040	80	5,632.00
14	8,213⅓	80	6,570.66⅔
16	9,386⅔	80	7,509.33⅓
18	10,560	80	8,448.00
8	4,693⅓	75	3,520.00
10	5,866⅔	75	4,400.00
12	7,040	75	5,280.00
14	8,213⅓	75	6,160.00
16	9,386⅔	75	7,040.00
18	10,560	75	7,920.00
8	4,693⅓	85	3,989.33⅓
10	5,866⅔	85	4,986.66⅔
12	7,040	85	5,984.00
14	8,213⅓	85	6,981.33⅓
16	9,386⅔	85	7,978.66⅔
18	10,560	85	8,976.00
8	4,693⅓	90	4,224.00
10	5,866⅔	90	5,280.00
12	7,040	90	6,336.00
14	8,213⅓	90	7,392.00
16	9,386⅔	90	8,448.00
18	10,560	90	9,504.00
8	4,693⅓	95	4,458.66⅔
10	5,866⅔	95	5,573.33⅓
12	7,040	95	6,688.00
14	8,213⅓	95	7,802.66⅔
16	9,386⅔	95	8,917.33⅓
18	10,560	95	10,032.00
8	4,693⅓	100	4,693.33⅓
10	5,866⅔	100	5,866.66⅔
12	7,040	100	7,040.00
14	8,213⅓	100	8,213.33⅓
16	9,386⅔	100	9,386.66⅔
18	10,560	100	10,560.00

A number of other interesting and valuable tables will be found in the report of the Alabama Survey cited.

Egyptian Drainage Project*

By D. R. BIRCH†

ONE of the most costly and comprehensive drainage projects for the reclamation of lands undertaken by any government in the world, and certainly the greatest enterprise of its kind in Mediterranean countries, has just been begun by the Egyptian government to make cultivable one million acres of fertile land in the delta of Lower Egypt. The reclaiming of these lands will necessitate an expenditure approaching $15,000,000 for drainage and approximately a like amount for irrigation. The work as planned will require over four years, and will be brought to completion about the end of 1915. The principal object of the project is to redeem a tract of unproductive land and bring a fertile but now worthless region of the delta under cotton cultivation. When this is done it is roughly estimated that the increase in value of the reclaimed and improved land will approximate $100,000,000. The land to be reclaimed is 90% government owned.

The two projects, known as the West Behera and Gharbia drainage systems, while entirely separate and distinct and many miles apart, will, nevertheless, be proceeded with coincidently. A feature of the western or Behera plan is the draining of Lake Mariout, which covers an area of over 35,000 acres. This lake, an ancient historical site, will thus disappear forever and be replaced by fertile cotton-producing fields equal to those found anywhere in the world.

Considering the Behera project separately, the total land to be placed under effective modern drainage approximates 480,000 acres, of which 330,000 acres are classed as cultivated. The latter area, however, is at present poor in producing qualities, and it is the theory of the government that when properly drained it will equal for cotton-growing purposes the best of the delta. The remainder is unfit for cultivation of any kind and comprises the 35,000 acres of Lake Mariout,

*Abstract from U. S. Consular Reports.
†U. S. Consul, Alexandria.

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

its arm, Lake Mallaha, and the low swampy land bordering on these lakes. All the territory covered by the Behera project is that which is now drained into Lake Mariout, which in turn is kept 3 metres (9.84 ft.) below sea-level by pumps at the station at Mex, just west of Alexandria. Lake Mariout is separated from the Mediterranean Sea by a narrow strip of land and is approximately 1 metre (3.28 ft.) deep. Twelve high-speed centrifugal pumps will be installed at the Mex pumping station and there will drain the lake and keep the subsoil water to a depth of 5.6 metres below sea-level. Each of these pumps requires 1000 brake-horsepower and has a lift of 6 metres.

The Gharbia project contemplates the draining of 470,250 acres, one-half of which is unfit for cultivation of any kind, and in the region comprising the other half, and classed as cultivated, the only crop raised is rice. All the land in this section is above water, and the drainage channels will convey the water down deep drains to Khassa, near Balteem. From there the water will be pumped into Lake Borollos, which opens into the Mediterranean. The pumps to be used in this section will probably be of the slow-speed turbine class having a lift of 2.5 metres. It is planned to install 15 such pumps of 350 hp. each, possibly operated by steam, which is considered as more satisfactory for slow speed.

The scope of the work in both districts includes the remodeling of all existing drains and the construction of new trunk lines leading to the pumping stations. All these will be at a uniform depth of 6 metres; the new ones to be constructed to that depth and existing drains to be lowered 3 metres below their present level. The layout of the drainage system when finished will insure that no individual plot of land is more than 2 kilometres (1¾ miles) away from a public state-maintained drain; and it will further insure that the water surface in such drains will always be at least 1.5 metres (5 ft.) below the adjacent cultivable land. Practically every acre of land in the two sections now uncultivable owing to deficient drainage, will be provided with a thorough drainage system, and the improvement of the channels of existing drains will facilitate their subsequent maintenance in a high state of efficiency at moderate cost.

The first cost of the work in the West Behera district is estimated at $6,950,000, and the maintenance of the drains when completed will approximate $660,000 annually. In the Gharbia province the first cost will be $5,960,000 and the yearly expenditure for maintenance $390,000.

This huge work, so important to the culture of Egyptian cotton, is conjectured to be but the first of a series of similar projects which in years to come will be carried out in Lower Egypt to bring the entire delta under cotton cultivation. It is believed that upon completion of the present work, providing the success hoped for is achieved, other and larger lakes bordering on the Mediterranean will be drained in the same manner as Lake Mariout and converted into cotton fields.

The necessity for some such project as now begun has long been recognized by the government. It was one of the first matters to engage the attention of Lord Kitchener, who, in November last, urged the immediate start of the work and arranged that the government's 1912 budget provide money from the reserve fund for the preliminary work. Sir William Garston and A. L. Webb, who act at times as consulting engineers of the Egyptian government, were called from England and made a careful investigation of the scheme as outlined, and the work will now be carried out as approved by these experts.

The present drainage project is regarded in importance to the future of Egypt as second only to the Assuan dam. This year will see the completion of the Assuan dam to its new level, which will mean that in 1913 the dam will hold about two and a quarter times as much water as hitherto, and thus provide ample water-supply for the irrigation of the land now to be drained.

The prosperity of Egypt lies almost entirely in its cotton crop, which approximates a value of $100,000,000 annually, and the government is consequently always alive to the importance of extending the cotton-growing area. At present the cotton fields of Egypt cover 1,603,266 acres, most of which are in the delta. The crop of 1911 was 650,000,000 lb., but there has within the past few years been a falling off in the yield of cotton per acre. Several years ago the acre gave 525 lb. of cotton, whereas the same land today averages only 440 lb. One of

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

the problems of the Irrigation Administration concerns the movement of subsoil water. In the lands now to be drained the subsoil water reaches, even on those now classed as cultivable, to within 4 or 5 ft. below the ground surface, and thus the feeding root of the cotton plant, which extends 1½ to 2 metres into the ground, is immersed in subsoil water. When the drainage projects are completed, the subsoil water in every acre of land in the drained districts will be kept more than 1½ metres below the level, and thus the cotton plant freed from its deleterious influences.

Observations on the Disintegration of Cinder Concrete*

By GEORGE BORROWMAN

CINDERS, as an aggregate in concrete, are used rather commonly where a light, cheap mixture is desirable; also in fireproof construction, and perhaps in the latter capacity this kind of concrete finds its most important application.

Its efficiency, however, has been the subject of considerable discussion. Various tests have been made, the results of which tend to show the superiority of this kind of material over all other fire-resisting substances. There are also several patented floors involving cinder concrete which have been used successfully. Nevertheless, it has failed in some instances when employed for ordinary purposes, cracking and disintegration taking place. These discordant results are due, no doubt, as Freitag suggests in his 'Fire-proofing of Steel Buildings,' to the use of cinders of varying quality, but to my knowledge the matter has not been further investigated. A particular case of disintegration, accompanied by a powdery efflorescence on the surface of the concrete, was observed by S. Avery, who prompted some study of the phenomena and also made various helpful suggestions during the experiments.

Blocks of concrete containing cement, sand, and quarter-inch cinders were first prepared, the proportions by weight being 1:2:3, respectively. The cinders were from steam coal and slack, and were carefully screened. The cement and sand were of good quality, the latter being sieved through 20 mesh and on 30. Another lot was then made up using cinders from ½ to 1 inch in size, the proportions being 1:1:1. In each case, just enough water was used to insure thorough incorporation without running. All the blocks were placed on a glass plate to prevent loss of moisture and covered with a damp cloth for two weeks. At the end of this period, the specimens having the proportions 1:2:3 showed no change, but were somewhat porous and friable, owing to the relatively large bulk of cinders. A little later, however, fine cracks developed, with general disintegration. The others (1:1:1), though compact and hard, also showed signs of cracking, and in a short time the breaks became very pronounced. In each case they radiated from certain points. These latter specimens were broken open to facilitate examination, and in some cases the breaks originated from cinders that showed oxidation of much iron. The surfaces of the concrete bounding the cracks crumbled easily, indicating more or less general weakening.

The appearance of these oxidized cinders suggested the presence, originally, of much ferrous iron, probably as sulphide. The analysis of the cinder stock showed considerable sulphur as sulphide and sulphate; also iron, though the proportion of ferrous iron could not be determined in material of this sort, with accuracy.

ANALYSIS OF CINDERS

	Per cent.
SiO_3	37.86
Fe, as Fe_2O_3	21.16
Al_2O_3	17.40
CaO	10.96
MgO	0.83
S	0.60
SO_3	5.82
Undetermined (C, etc.)	5.37
	100.00

It seemed probable, then, from the fore-

*Abstract from the *Jour. Ind. & Eng. Chemistry*, June 1912.

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

going data, that oxidation of iron and sulphur produced internal stress and consequent cracking, aided, no doubt, by the general weakness produced by the diffusion of soluble sulphates. This theory was further strengthened by finding that the efflorescence found on the surface of the disintegrating concrete, before mentioned, was ferrous sulphate.

On this assumption attempts were made to bring about similar results by substituting for cinders artificial iron sulphide, prepared in several ways. These experiments, however, were not successful. On breaking open the blocks, the sulphide was found to be unchanged, surrounded by hard, compact cement. Soluble sulphates being absent in the mixture, the blocks had, of course, greater initial strength than those containing cinders and would have withstood considerable stress had there been any. The lack of oxidation, though, in these tests, indicated that in the case of the cinders the necessary oxygen must have come from the cinders themselves, since they were equally well protected from the air.

This conclusion drew attention to the fact that about one-third of the cinder stock consisted of a very porous coke. As is well known, this substance will persistently occlude large amounts of oxygen. According to Starr and Lewis, air-dried coke contains absorbed gases in the proportion of about 0.7 c.c. per gram of coke, 2 to 6% of the gases being oxygen. The oxidation in the concrete was most pronounced in the coke. Moreover, some pieces of the latter were picked from the cinder stock and tested for sulphide sulphur, about 1% being found. The nodule from which the cracks radiate proved to be a piece of coke so thoroughly oxidized as to look like a mass of ferric oxide. This was tested and found to contain but a trace of sulphur.

As a final experiment, some of the original stock of cinders was kept exposed to air and moisture until, on washing, they showed the presence of no soluble sulphate. They were then made into a block of concrete similar to those prepared before (1:1:1). Under parallel conditions, no disturbance took place, the material retaining perfect stability.

From these tests the conclusion may be drawn that cinders with much sulphide and sulphate sulphur are likely to give unsatisfactory results, especially if there is much coke or porous material present; also, that such material may be improved if allowed to weather, with occasional washing, until the ferrous iron and sulphur have been oxidized and leached out.

Variable Speed Drive*

BY far the most general method of driving centrifugal pumps is at constant speed. To show that this way is not conducive to best economy where variable conditions are to be met, is the purpose of this article. It seems likely that the trend toward constant speed drive is due to the fixety of speed in motors, particularly of the alternating current type, and quite largely so when the slower speed drives are used, such as belt, rope, chain, or geared. The direct connected steam turbine drive or direct current motor applications offer good chances for variation in speed. Why this opportunity for variation in speed is not more often used is hard to explain, except by laying it to general inertia in the pump trade.

Certain relations applying to centrifugal machinery must be reviewed and explained before the text of this paper can be considered. At constant speed, three curves may be plotted with quantity as abscissæ and head, efficiency and brake-horsepower as ordinates to graphically describe a certain pump. These curves cannot be altered except by changes in design or conditions of operation, for example, increasing the suction lift.

Starting with these characteristic curves as fixed, we will consider a higher speed test with the same pump. The head at all points of equal capacity is higher, the horse-power similarly is greater, and the efficiency curve is distorted to give best results at greater quantity. These changes are illustrated in Fig. 1. Slower speed, of course, gives analogous results. Upon investigation it has been found that for any given design the

*Abstract from *Engineering Record*, June 8, 1912.

Generated on 2024-09-29 23:47 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

quantity at best efficiency equals a constant times the speed. Within quite wide limits, subject to very small error, the same relation is true at constant efficiency. That is, the quantity varies directly as the speed, while the efficiency remains fixed. Stating algebraically:

$$Q = KN \qquad (A)$$

Again, at constant efficiency the head equals a constant times the square of the speed. That is

$$h = kN^2 \qquad (B)$$

Also the horse-power under these circumstances equals a constant times the cube of the speed.

$$P = cN^3 \qquad (C)$$

From A and B we can derive an equation between quantity and pressure for constant efficiency. The square of the quantity equals a constant times the head

$$Q^2 = Ch \qquad (D)$$

This is the equation of a parabola.

Recalling that horse-power from falling water equals quantity in gallons per minute multiplied by head in feet and divided by 3960 ($P = Qh/3960$), we can turn to a problem showing the advantage of variable speed.

Suppose it is desired to pump from 6000 to 12,000 gal. per minute, depending upon the demand, and that the head varies from 52.5 to 60 ft. for these conditions. Consider the steam turbine drive.

In Fig. 2 curves are plotted to show the variation of capacity and head for a pump at speeds based on percentages of normal. Also the parabolas of constant efficiency are plotted, with a typical efficiency curve at constant speed.

The results in Fig. 2 show the effect of varying speed in percentages of normal speed of pump. While the results are calculated, they conform closely enough to test to be reliable for the conclusions desired. It will be noted that the normal service of the unit is to deliver 12,000 gal. per minute at a total head of 60 ft. and the maximum efficiency is 70%, occurring at normal rating. For quantities less than normal at lower heads, the advantage of change in speed can be seen.

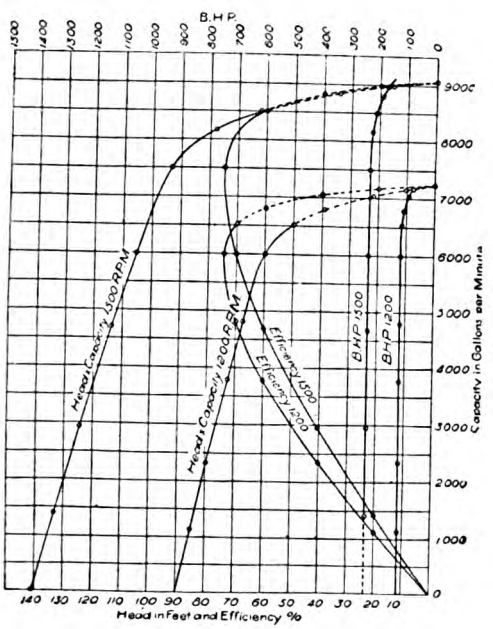


FIG. 1.

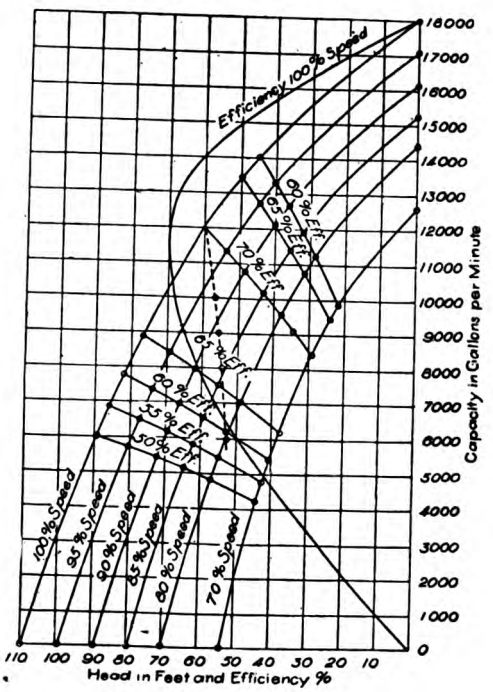


FIG. 2.

In Fig. 3 characteristic curves of a high grade constant speed pump are shown. The capacity head curve is very flat to allow variable demand.

Three methods of accomplishing the operating conditions, mentioned in the problem, will be considered. First, consider the

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

pump whose curves are shown in Fig. 2 to run at 100% speed. The results are tabulated under method A.

Next, compare the pump of Fig. 3 similarly. The corresponding figures are given under method B in the table.

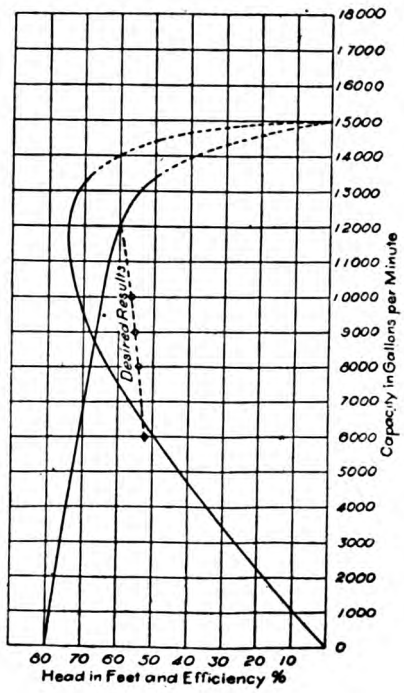


FIG. 3.

Lastly, from Fig. 2, determine what results may be had by running that pump at variable speed. These results are tabulated under method C.

The table embodies the final comparison of the three methods. For constant speed drive, the flat curve of Fig. 3 is found better than the sloping one of Fig. 2, although the latter pump runs at higher speed. The variable speed results speak for themselves and demonstrate the point which this article attempts to prove.

No doubt variable speed drive for centrifugal pumps will be more usual as the desirable features become known, and then definite commercial results may be compared.

TABULATION OF RESULTS.

METHOD A, USING THE PUMP WHOSE CHARACTERISTICS ARE SHOWN IN FIG. B, RUNNING AT 100 PER CENT SPEED.

Quantity	Actual Head on Pump	Efficiency	B.H.P.	Turbine Water Rate	Total Steam
12,000	60	70	260	40	10,400
10,000	71.4	68.3	264	40	10,560
9,000	76.4	65.5	265	40	10,600
8,000	81.1	61.5	267	40	10,700
6,000	89	50	270	40	10,800

METHOD B, USING THE PUMP WHOSE CHARACTERISTICS ARE SHOWN IN FIG. 3, RUNNING AT CONSTANT SPEED.

Quantity	Actual Head on Pump	Efficiency	B.H.P.	Turbine Water Rate	Total Steam
12,000	60	75 *	242.4	43	10,400
10,000	64.5	71.5	228.0	44	10,050
9,000	66.4	68	222.0	44	9,700
8,000	68	63.2	217.0	44	9,550
6,000	71.2	50	216.0	44	9,500

*It is assumed that the pump of Fig. 3 is slightly slower speed than that of Fig. 2.

METHOD C, USING THE PUMP ILLUSTRATED IN FIG. 2, RUNNING AT VARIABLE SPEED.

Quantity	Actual Head	Efficiency	B.H.P.	Speed Per Cent	Turbine Water Rate	Total Steam
12,000	60	70	260	100	40	10,400
10,000	56.95	68.5	210	92	42	8,830
9,000	55.63	67.0	188.8	89	43	8,120
8,000	54.5	65.5	168.4	85	44	7,410
6,000	52.5	59.0	135	79½	48	6,480

COMPARISON OF RESULTS WITH THREE METHODS OF ACCOMPLISHING CERTAIN SERVICE CONDITIONS.

Quantity	Corresponding Pressure	Actual Useful H.P.	Total Steam (A)	Total Steam (B)	Total Steam (C)
12,000	60	181.8	10,400	10,400	10,400
10,000	56.95	143.8	10,580	10,050	8,830
9,000	55.63	126.4	10,600	9,760	8,120
8,000	54.5	110.2	10,700	9,550	7,410
6,000	52.5	79.55	10,800	9,500	6,480

The Diesel Engine*

By RUDOLPH DIESEL

THERE have been so many publications recently, especially during the past year, on the construction of the Diesel engine and its various types, that it is hardly possible to give any fresh information on this subject. I propose, therefore, to consider the working principle and construction of my engine to be generally known and to discuss only questions of general importance. Since its first appearance in 1897, many Diesel engines have been built in all industrial countries, and it has proved reliable when properly constructed. The thermal or indicated efficiency now reaches 48% in this engine, and the effective or brake efficiency in some cases 35% of the heat values of the fuel.

*Abstract from *Journal* of the American Society of Mechanical Engineers, June 1912.

Generated on 2024-09-29 23:51 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Fig. 1 shows the heat utilization for 1 b.hp.hr. in the different kinds of prime movers now known, and Fig. 2 shows a comparison of working and test results of steam plants, gas plants, and Diesel-engine plants.

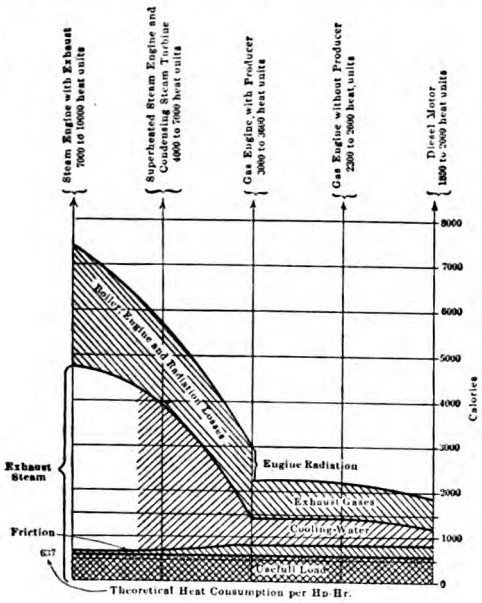


FIG. 1.

The Diesel engine converts the heat of the natural fuel into work in the cylinder itself without any previous transforming process, and utilizes it as far as the present standard of science permits; it is, therefore, the simplest and at the same time the most economical prime mover. The working process for both the four-stroke cycle and two-stroke cycle engines is shown in Fig. 3, and indicator diagrams in Fig. 4.

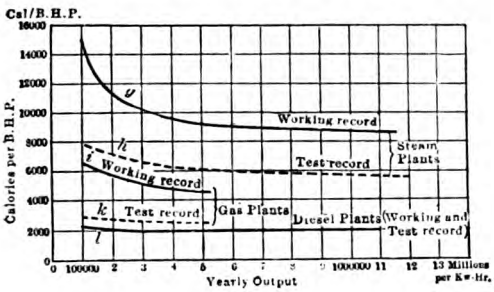


FIG. 2.

The success of the Diesel engine is not due to constructional improvements or alterations of older types of engines, but to its new principle of the internal working-process. A further reason is that the Diesel engine has broken the monopoly of coal, and has solved the problem of using liquid fuel for power production in its simplest and most general form. It has become for all liquid fuels what the steam engine and gas engine are for coal, but in a much simpler and more economical way. The truth of this statement was strikingly proved at the Turin exhibition of last year, where a steam turbine and a large Diesel engine, both made by Franco Tosi of Milan and set up on the same stand, were worked together with the same liquid fuel. The boilers belonging to the plant were fitted with Koerting nozzles for burning crude oil. The difference between the two plants was, therefore, that for the working of the steam engine, there had to

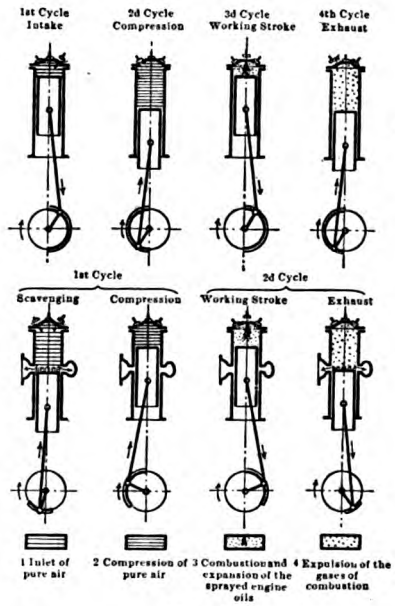


FIG. 3.

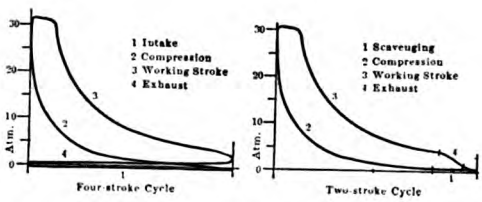


FIG. 4.

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

be provided the whole boiler plant with its chimney, fuel supply apparatus, feed pumps, and purification plant for feedwater, and steam piping; and the condensation plant with auxiliaries and an enormous water consumption. The steam plant showed a final result of two and one-half or more times the fuel per horse-power per hour required by the Diesel engine standing beside it. The latter, being an entirely independent engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct into its cylinders without any residue or smoke.

Thus the Diesel engine can double the resources of mankind as regards power production, and has made new and hitherto unutilized products of nature available for motor power. The Diesel engine has thereby exercised a far-reaching influence on the liquid-fuel industry, which is at the present time improving more rapidly than was previously conceived possible. This is not the place to discuss this matter in detail, but I wish to mention that, owing to the interest which petroleum producers have taken in this important question, new petroleum sources are continually being developed and new oil districts discovered. Moreover, it has been proved by recent geological researches that there is probably on the globe not only as much but even more liquid fuel than coal, and also that it is more conveniently distributed as regards its geographical position. These facts, which are indisputable, have gradually silenced those who objected to too great a development of the Diesel engine for fear of insufficient stores of liquid fuel.

That the auxiliary industries of petroleum production are also considerably influenced is shown by the great increase which the transport industry for liquid fuel has experienced in recent times, especially in the great development of tank vessels, which are, or will be, mostly driven by Diesel engines.

But with all this, the influence of the Diesel engine on the world's industries is not exhausted. As early as the year 1899, I utilized in my experimental engine the by-products of coal distillation and coke plants, such as tar and creosote oils, with the same satisfactory results as with natural liquid fuels, but at that time the quality of these oils was generally too inferior for their use in the Diesel engine, and it was, moreover, subject to continual variations. It is only in recent years that the chemical industries interested in the matter have, by improved methods of fractioning and refining, combined with more careful selection of the material, succeeded in supplying fuel of a constant and regular quality without the drawbacks of the crude tar oils used previously. These products, the tar and tar oils, are thus definitely brought into the sphere of activity of the Diesel engine.

This fact is not so important in the United States because of its richness in natural oil, but it is for European countries, especially those countries not having an oil production of their own. It may be of interest to state, for instance, that the tar production of Germany is sufficient for more than five millions of horse-power-hours per year, which means about one and three-quarter millions of horse-power running 300 days for ten hours each all the year. In case of war and the cutting off of the supply of foreign fuel, this quantity would be sufficient to run the whole fleet, war and mercantile, and to provide in the meantime the power for the inland industries so far as necessary.

In this connection it is a pleasure to say that the first industrial utilization of the by-products of gas manufacture by Diesel engines was made in this country by E. D. Meier, who, in the year 1904, was the first to burn water gas tar of the gas works in Philadelphia in regular work for Diesel engines.

It will be seen from this that the influence of the Diesel engine on two other industries is increasing the manufacture of gas and coke, the by-products of which have become so important for power production that an enormous business is at present connected with them. It is especially noteworthy that every modern gas or coke works can be arranged to generate electric power by using its tar in Diesel engines. One fact which stands out clearly in this connection is that coal, which seemed to be most threatened by liquid fuels, will, on the contrary, gain a new and wider ground of application through the Diesel engine. As tar and tar oils are from three to five times more satisfactorily utilized in the Diesel engine than coal in the steam engine, a much better and more economical consumption of coal is obtained if, instead of being burned under boilers on grates in a wasteful way, it is first trans-

Generated on 2024-09-29 23:49 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

formed into coke and tar by distillation. Coke is used in metallurgical and other general heating purposes, and from a part of the tar the valuable by-products are first extracted and undergo further processes in the chemical industry, while the tar oils and combustible by-products and a great part of the tar itself are burned in the Diesel engine under very favorable conditions.

It is evident that these circumstances are of differing importance in different countries, some of which are exclusively coal countries, others oil countries, and others again, like the United States, mixed coal and oil countries. It is difficult to predict what development will take place in a given country, but it is certain that the possibility of burning the by-product of gas works and coke ovens in the Diesel engine has resulted in Europe in making the different countries independent as regards their supply of liquid fuel and has prevented increase in price of natural liquid fuel and the establishment of trusts or monopoly companies. This condition has been reached, not by laws or artificial means, but by the invincible force of scientific investigation and industrial progress before which the mightiest must bow.

The following statement may be made. The proper development of the utilization of fuel which has already been started and is now making rapid progress consists, on the one hand, of the use of liquid fuel in Diesel engines, and, on the other, of gas fuel, also in the form of gasified coke, in the gas engines; solid fuel as little as possible for steam-power generation, but as much as possible in the refined form of coke for all other heating and metallurgical purposes.

It is not generally known that it is possible also to burn vegetable and animal oils in the Diesel engine without difficulty. The first trials were made at the Paris Exposition in 1900 with earth-nut oil, and I have since then repeated them with castor oil and palm oil, and also with animal oils such as train oil. The use of vegetable oils may seem insignificant now, but may have in course of time an importance equal to that of same natural mineral oils and the tar products at the present time. One can not tell what part these oils will play in the colonies of the future. In any case, it is certain that motor power can still be produced from the heat of the sun, which is always available for agricultural purposes, even when all our natural stores of solid and liquid fuels are exhausted.

Concrete Roads of Wayne County, Michigan*

By GEORGE A. DINGMAN†

THE Wayne county board of road commissioners, by whom I am employed, became interested in 1909 in the use of concrete as road material, and after a thorough investigation of the subject from all angles, decided to try it on a mile of road about to be constructed on Woodward avenue. Since this road was built, the board has become so firmly converted to the use of concrete as a country road pavement, that up to January 1, of this year, they had built 30½ miles of this form of pavement. It can be said truthfully that they are pioneers, not in the use of concrete for pavement, but in its use on so large a scale.

In 1908 the board built several miles of macadam road. Owing to the difficulty of securing a sufficient supply of crushed hard stone for the second course during the road-building season, a supply of crushed field-cobbles was purchased during the winter with the idea of using it the following season for the second course or wearing surface of the macadam. Before the time to build the second season's stretch of the road arrived, however, they noticed the result of automobile traffic on the macadam, and decided that before any more money was expended on that form of construction they would at least investigate and see if some more durable form of improvement could not be found. It might be well to mention in this connection, also, that the macadam roads which they built were covered with a coating of tar and chips, with the idea of making them not only dustless, but more firmly

*Abstract from *Engineering & Contracting*, June 19, 1912.

†Engineer, County Road Commission.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

bound, increasing the resistance to wear.

After a full investigation and consultation with several engineers, besides the engineers on the regular force, it was thought best to utilize the hard stone purchased as above in building the second course of a concrete road rather than macadam. Accordingly, bids were asked for the construction of one mile of concrete road built in two courses, the first or bottom course to be of limestone, 1-2½-5 mix, and the second course, or wearing surface, of crushed cobblestone, using a 1-2-3 mix. A satisfactory bid was received and the contract awarded. Work was started in May, and the road was finished and thrown open to traffic about August 1. No sooner had this road been thrown open to the traffic than the board decided to build another stretch of concrete on Grand River road in the construction of a short stretch there, built according to the same specification as the Woodward avenue road.

By this time Woodward avenue had been subjected to considerable traffic, and on account of its standing up so well, showing, in fact, no signs of wear, and there being no apparent weaknesses developing, they decided to build a third stretch, and built one-half mile on the Wayne road south. This road is less important than either of the other two, and was built but 10 ft. wide. It was finished late in the fall of 1909 and had to be protected from the frost by manure and other means. The following year 11.3 miles of concrete road was built and in 1911, 17 miles was constructed.

Method of Construction

Grading.—The first work done in the construction of our concrete roads, of course, is to grade and prepare the subgrade. This is done by means of steam hauling engines and rollers and road graders and scarifiers. At some places we also find it necessary to use the rooter plow, and where grades are too steep, we use scrapers for short hauls and wagons for longer hauls.

The surface of the subgrade is shaped to conform to the curvature of the finished road, and is thoroughly rolled with one of our 10-ton road rollers. Where soft or spongy places appear, they are filled with gravel or suitable substance until the foundation is made solid. If necessary, the soft or spongy material is first removed, though it is rarely necessary to do this, the fill being all that is needed to make the foundation right.

Concrete Materials.—While the law requires the board to advertise for proposals for all material and all work done which cost in excess of $500, and while, other things being equal, the board would undoubtedly award the contract for material to the lowest bidder, the fact is that no two cements are exactly alike, and hence it follows that other things are never exactly equal. When bids are opened on cement (each proposal must be accompanied by a liberal sample) they are held up for a period of 30 days, to enable us to make thorough tests, including the 28-day test, before the contract is awarded. It also frequently happens that the board will go out into the market and purchase single sacks of the same kind of cement bid upon from several different yards, and not only make tests themselves, but have laboratories of established reputation make tests also, the idea being to see if a sample of exceptionally good cement has been furnished, and also to ascertain whether the quality of cement put out by the mill is uniform. If the cement fails to meet the requirements established by the American Society for Testing Materials, it is not considered further, the use to which the material is put requiring better quality than even foundations or walls of high buildings. For in buildings, the strain is constant, except as variations are produced by the winds, while on roads the strain is sudden and severe. It would be much better to leave the earth roads and keep them well graded than to build a concrete road of poor cement or build it any way other than exactly right.

For stone we use washed gravel, ranging in size from ¼ to 1½ in. This contains a large percentage of trap rock, and is required by our specifications to be free from loam, clay, vegetable matter, and other impurities; also to be well graded, the larger pieces predominating, so that the voids are reduced to a minimum.

For sand we use only well graded bank sand, ranging in size from ¼ in. to zero. Lake and river sand is not approved, because of the presence in it of too many fine particles which would require too large a proportion of cement to properly coat every particle. Like the stone, the sand must be free from impurities, well graded, the larger particles predominating, and the voids reduced to a minimum.

The Mix.—On the first year's work, as

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

above stated, the mix for the first or bottom course was 1-2½-5, and for the top or wearing course the mix was 1-2-3. We determined that with a perfect mix, and with perfect conditions, a 1-2-4 mix with pebbles would be sufficient. But our commissioners are conservative, and at once realized that theoretically perfect conditions would never obtain, and decided that it would be the part of wisdom to use too much cement rather than too little. Accordingly, they adopted a 2-3-6 mix, which has been adhered to. With well graded materials this is ample, with enough to spare, so that when the material is not perfectly graded, or when other conditions exist requiring a little additional cement, there is plenty of the more expensive material. Under perfect conditions, as above stated, a poorer mix could be used with safety, but a concrete road with too little cement is bound to disappoint, and to be safe and conservative, as above stated, we use a 2-3-6, feeling assured that the certainty of having the road stand up is worth the additional expense.

We have purchased mixers which are provided with a boom 18 ft. long, which extends to the rear, and can be easily revolved about the axis to positions varying 180°. On this boom a bucket is run back and forth, by hand, and in it the mixed product is conveyed from the mixer to the road. On account of the movability of the boom, the concrete is deposited wherever wanted, and the expense of six or eight men to haul the concrete in carts from the machine to the place required is reduced to two.

After dumping, the concrete is well tamped, then stroked off with a 'strike board' having its under side curved to correspond with the desired crown of the road; after which one or two 'floaters' smooth off the rough surface and even up any depressions or humps that may appear. The surface is left just rough enough to afford a good foothold for horses and resistance to automobile tires.

The first day the concrete is protected from the sun by canvases. After final set has taken place the canvases are removed and the road covered with 1 or 2 in. of loose earth to prevent it from drying out. It is also our practice to sprinkle the concrete, more or less, depending on the state of the weather. In dry weather the concrete should be sprinkled at least once a day for seven days. If the road is not situated where trespassers are likely to come, the night watchman can attend to the sprinkling.

Expansion.—The first year we used two thicknesses of 3-ply tar paper between the sections only which are made 25 ft. in length. This affords sufficient expansion, but we soon noticed that at the joint the wear could be detected, due to the impact of horses' shoes and wheels under heavy loads chipping off the edges. This wear was not great; in fact, even now, after four years' wear, the joint cannot be noticed except on a vehicle heavily loaded and without springs. But the fact that chipping and wear did take place at the joints more than at any other point in the road, led us to look for a more durable joint, or some other form of protection.

We finally decided to use two sheets of soft steel 1¼ in. thick and about 3 in. wide, sheared to conform to the crown of the road. Shear members are cut in the plate at frequent intervals and bent out. They are firmly imbedded in the concrete, which holds the steel exactly in place, at the corner of the concrete in the section. These steel joints are patented. Of course, the cost is higher than that of tar paper, which we originally used, but the additional expense is beyond a doubt an ultimate economy. Between the adjacent steel plates we place a sheet of asphalt felt, which takes up the expansion in the concrete.

Mixers.—We use batch mixers only. These are propelled by their own power when on the job, but not from one job to another, as they can move only about two miles an hour on the road, and are too heavy and too clumsy for a road vehicle. The boom on the rear is about 18 ft. long, so the mixer is moved a distance of about 15 ft. each time. This traction power and boom arrangement are both necessary for the reduction of labor behind the machine.

By moving at short intervals, the machine is kept near the source of supply of materials; and if it should ever happen that the material is not left in quantities sufficiently liberal, a team wagonload of gravel, sand, or cement can easily be hauled in to make up the deficiency.

Water Supply.—The supply of water in sufficient quantities has been a vexatious problem. It was formerly necessary to team the water in 12-barrel tanks. With teams costing 50c. per hour, this proved a very

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

expensive method of procuring water. This has been overcome by the purchase of several gasoline pumps and a large quantity (nearly 10 miles) of 2-in. black pipe. This pipe is laid alongside the road to be improved with connections every 150 ft., so it can be tapped at short intervals. During the day this furnishes ample water for the mixer and the hauling engines, and also for sprinkling when it is done in the day. When the sprinkling is done at night, of course, the demand on the engine is decreased. We found it necessary in some cases to pump as far as five miles, in relays, using three pumps, but even pumping this distance was found to be economical as compared with hauling in tank-wagons by teams.

Drainage.—All road builders are agreed that no road will stand up that is not properly drained. We provide not only for taking the water off quickly in ordinary weather but also against flood times. When we come upon a wooden culvert 4 ft. wide we replace it with a concrete culvert 6 or even 8 or 10 ft. wide, having first determined by survey the area to be drained by it. We are liberal to a degree in the matter of drainage, and especially so with the dimensions of culverts and tile used.

Where electric railways run along the side of the road, as they do in many of Wayne county's roads, we lay a land tile, 3 in. diameter, alongside the track, distant from the nearest rail about 4 ft. We cover the top of this course of tile with tar paper to prevent filling up by the washing of sand, etc.

For crossings, either of the road or private drives, etc., we use concrete tile which we manufacture. The diameters are 8, 12, and 24 in. We maintain a force at our storage sheds the year round, which when not otherwise engaged makes concrete tile. We use the tongue and bevel forms, and the product of the tile factory is of better quality and much cheaper than can be secured in the open market. For cement tile we use a 1-3 mix of the same cement and sand that we use on our roads. If the sand is fine, of course a little richer mix should be used, but it not only saves money, but also time, to insist upon the sand being coarse. Even a few pebbles up to ⅜ or ½ in. are not objectionable.

Interchangeable Culvert Form.—We have a standard plan and interchangeable design for all our culverts. The sketch or blueprint provides for whatever width of culvert we elect to build. It also provides for a variable span, though we confine our operations to an even number of feet, ranging from 4 to about 14 ft. We also have a table showing what reinforcements are necessary for a 4-ft. span, a 6-ft. span, and so on, so that practically all the drawing or planning we have to do in our culvert construction is to determine what the width and span shall be, and fill in the figures on our interchangeable blueprint. This not only saves time, but also gives uniformity of appearance to the completed culverts. With the aid of the form and the table of reinforcements, the work of ordering the materials and computing volumes, etc., may be done by a novice.

Costs.—As widths of roads vary, it has been thought best to give the costs on a square yard basis. On a 9-ft. road the cost is the number of feet to be built, multiplied by the cost per square yard. For a 10-ft. road one-ninth should be added. For a 12-ft. road one-third should be added, and so on. Our costs have ranged all the way from $1.25 to $1.75 per square yard. These figures are arrived at on the basis of roadway proper, and do not include drainage. The cost of our drainage is about 5% of the total cost of the road. Labor is about 32 to 40% of the total cost.

A variation in the above figures will obtain in every locality. It depends upon innumerable conditions, chief among which may be mentioned condition of subgrade, character of the country, whether hilly or level, length of haul from nearest available sidetrack, condition of road over which material must be hauled, freight rate from source of supply to sidetrack, kind of motive power used for hauling, kind of mixer used, especially with reference to labor-saving devices and capacity, kind of weather prevailing, prices paid for labor and teams, ease or difficulty of securing adequate supply of water. It might also be mentioned that the ability of the foreman has a great deal to do with the cost, as to whether he is a capable hustling pusher and gets out of the men all there is in them, or whether he is a poor handler of the men and fails to manage them to best advantage.

Maintenance.—While our macadam roads cost in the first instance about 10% less than our concrete, the fact is that up to this time they have cost as much, due to the

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

maintenance charges that have been necessary to keep them in good usable shape. On our 30 miles of concrete road we have not spent to exceed $200 in maintenance, and most of this has been spent in cleaning out the ditches and drains, painting guard rails of culverts, and cutting weeds. The repairs to the concrete itself have been negligible.

With maintenance cost may be mentioned durability, part of which is ability to resist the ravages of the automobile. There are no loose stones or particles in the concrete road, but every particle is soldered or cemented to the monolith which we call a section, 25 ft. long and as wide as the road metal is built. The suction of the automobile tires cannot budge it.

The longevity of the road is not known. The pavement laid in Bellefontaine, Ohio, twenty-one years ago, is in good condition today, and I do not believe it is presumptuous to say that it will in all probability last as many more years. Our roads are built of a richer mix and of better material. With the steel joints we are now using, it does not seem as though 50 years' wear is too much to expect from the concrete road.

The surface of the concrete road is just rough enough to afford good footing for horses and for automobiles, thereby affording good traction. The objection has been raised that it is hard on the horses' feet, and this is probably true, though we fail to see how it can be any harder on them than brick. This objection, however, is one reason that has been advanced for coating the surface with tar and sand, and if this is done, the objection is overcome. And while the concrete road may be a little harder on the horses' hoofs, it is also just as certain that it is easier, and in greater degree, on the muscles.

The concrete road is also dustless, there being no detritus from the road itself. The road is also the most sanitary of roads, as every good rain cleans it of all foreign matter brought on to it, with the possible exception of where clay has accumulated in large quantities. It is also sightly and pleasing to the eye. If the tar coating is given, with sand enough to absorb the tar, it has the appearance of an asphalt road.

Repairing Concrete Roads. — Contrary to general opinion, the concrete road can be repaired if it should require repairs. If built right in the first instance, it should not need repairs, but when it is considered that 2550 tons of gravel is used in the construction of a mile of this road 15 ft. wide, 7 in. deep, and that each ton contains 150 shovelfuls, it is almost too much to expect that every shovelful will be free from foreign substance and that every cubic foot will be mixed exactly as it should be. The proper way to make repairs is to cut out the piece found faulty, beveling the edges of the cut so that it is wider at the top than at the bottom. Considerable slant should be given the sides, and the sides should be left rough, not so the new concrete will adhere to the old (for it will not in sufficient degree), but so the new concrete cannot sink or slide around. It is true that there will be some adhesion between the new and the old, but not enough to give the same strength to the joint as in the concrete that goes to make up the old and the new; the sloping edges and rough sides will give added strength.

Developed Water-Power in the Western States

WATER-POWER development in the United States is the subject of an exhaustive report by Herbert Knox Smith, Commissioner of Corporations in the Department of Commerce and Labor, under date of March 14, 1912. The following abstract from Table 8 gives a summary of the developed water-power in the Western states for concerns having 1000 hp. or more.

The total stationary power now in use in the United States, according to the report, is probably in excess of 30,000,000 hp., of which the total developed water-power is 6,000,000 hp. The total potential water-power that is capable of being developed economically probably does not exceed 25,000,000 hp. It will be noted that in California six large corporations control about 375,000 hp. or 86% of the total developed in the state, while in Washington, two companies control 210,000 hp. or about 70% of the total in that state.

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

DEVELOPED WATER-POWER IN THE WESTERN STATES

Owner.	Location.	Stream.	Developed and under construction (wheel installation). Commercial. (hp.)	Developed and under construction (wheel installation). Manufacturing. (hp.)	Undeveloped (hp.)	Total (hp.)
ARIZONA						
Arizona Power Co.	Yavapai county	Verde river	9,000	.....	.....	9,000
United States Reclamation Service.	Roosevelt dam	Salt river	7,200	.....	.....	7,200
Total			16,200	.....	.....	16,200
CALIFORNIA						
Great Western Power Co.	Big Bend and Big Meadows	North Fork of Feather river	60,000	.....	300,000	360,000
Pacific Gas & Electric Co.	5 subsidiary companies; 11 plants.	Feather, American, and Mokelumne rivers.	118,343	.....	100,000	218,343
Northern Cal. Power Co. (Con.)	Fern, Shingleton, Manton, Paynes Creek, and Balls Ferry.	Cow, Battle, and Paynes creeks	46,900	.....	124,000	170,900
Los Angeles, Bureau of Aqueduct.	3 plants in Inyo county	Cottonwood and Division creeks	2,585	.....	117,415	120,000
Sierra & San Francisco Power Co.	Sonora, Subletts Crossing, Tuolumne county.	Stanislaus river	65,500	.....	50,000	115,500
Pacific Light & Power Corporation.	7 plants: Riverside, Borel, Mentone, San Antonio, and Fresno (2 not given).	Kern, Santa Ana, San Gabriel rivers, San Antonio creek, Irrigation ditch, and North Fork San Joaquin river.	45,400	.....	10,000	55,400
Southern California Edison Co.	7 plants: 2 at Redlands, 5 not given.	Kern, Mohave, Santa Ana rivers	38,540	.....	.....	38,540
Nevada-California Power Co.	Bishop	Bishop creek, tributary Owens river	15,333	.....	10,667	26,000
Snow Mountain Water & Power Co.	Mendocino county	Eel river	8,000	.....	10,000	18,000
Sacramento Valley Power Co.	Redding	Cow and Snow creeks	5,000	.....	10,000	15,000
Mount Whitney Power & Elec. Co.	Near Visalia	Kaweah river	8,700	.....	.....	8,700
Western States Gas & Electric Co.	Placerville and Junction City	American and Trinity rivers	8,000	.....	.....	8,000
Oro Water, Light & Power Co.	2 plants at Oroville	West branch Feather river	.....	6,000	.....	6,000
Concerns (5) with 1000 but less than 3000 hp.			7,166	.....	667	7,833
Total			429,467	6,000	732,749	1,168,216

Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Colorado						
Central Colorado Power Co.	Glenwood Springs, Kremmling, and 30 miles from Denver.	Grand river and Middle Boulder creek.	39,000	.....	50,000	89,000
Commonwealth Power & Elec. Co.	Black Tail Canyon	Grand river	5,000	.....	5,000	10,000
Telluride Power Co.	Old Ames, New Ames, Ilium, and Ouray.	San Miguel and Gunnison rivers	9,450	.....	.....	9,450
San Juan Water & Power Co.	Tacoma	Animas river	8,000	.....	.....	8,000
Colorado Springs L. H. & P. Co.	Manitou	Colorado Springs water supply	3,000	.....	4,000	7,000
Concerns (3) with 1000 but less than 3000 hp.			5,240	.....	.....	5,240
Total			69,690	.....	59,000	128,690
Idaho						
Telluride Power Co.	Grace	Bear river	18,700	.....	21,300	40,000
Idaho Consolidated Power Co.	American Falls	Snake river	3,000	.....	17,000	20,000
Washington Water Power Co.	Post Falls	Spokane river	18,000	.....	.....	18,000
United States Reclamation Service.	Minidoka	Snake river	6,000	.....	4,000	10,000
Idaho-Oregon Light & Power Co.	Payette irrigation ditch	Boise and Snake rivers	4,400	.....	.....	4,400
Concerns (1) with 1000 but less than 3000 hp.			2,000	.....	.....	2,000
Total			52,100	.....	42,300	94,400
Montana						
Butte Electric & Power Co.	Divide, Madison, Canyon, Great Falls, Billings, and Livingston.	Big Hole, Madison, Missouri, and Yellowstone rivers.	69,260	.....	97,600	166,860
United Missouri River Power Co.	Canyon Ferry, Hauser Lake, Holter.	Missouri river	65,000	.....	.....	65,000
Northern Idaho & Mont. Power Co.	Kalispell	Swan river	2,500	.....	8,100	10,600
Concerns (1) with 1000 but less than 3000 hp.			2,500	.....	.....	2,500
Total			139,260	.....	105,700	244,960
Nevada						
Sierra Pacific Electric Co.	3 plants near Verdi, 2 near Reno	Truckee river	14,200	.....	24,000	38,200
Oregon						
Portland Railway L. & P. Co.	Cazadero, Oregon City, and Silverton.	Clackamas and Willamette rivers, and Silver creek.	48,000	.....	75,000	123,000
Mount Hood Railway & Power Co.	20 miles east of Portland	Big and Little Sandy rivers	16,000	.....	50,000	66,000
Idaho-Oregon Light & Power Co.	Ox Bow	Snake river	18,600	.....	18,600	37,200
American Power & Light Co.	Milton, Tygh Valley, Hood River.	Walla Walla, White and Hood rivers	7,760	.....	.....	7,760
Concerns (2) with 1000 but less than 3000 hp.			5,417	.....	.....	5,417
Total			95,777	.....	143,600	239,377

Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Owner.	Location.	Stream.	Developed and under construction (wheel installation). Commercial. (hp.)	Developed and under construction (wheel installation). Manufacturing. (hp.)	Undeveloped (hp.)	Total (hp.)
South Dakota						
Consolidated Power & Light Co. of South Dakota	Deadwood Spearfish	Cheyenne river Red Water river	2,000	.....	2,500	4,500
Sioux Falls Light & Power Co.	Sioux Falls	Big Sioux river	3,000	.....	667	3,667
Total			5,000	.....	3,167	8,167
Utah						
Telluride Power Co.	Provo, Jordan Narrows, Logan, and Battle creek.	Provo, Jordan, and Logan rivers and Battle creek.	23,700	.....	.....	23,700
Utah Light & Railway Co.	4 plants	Ogden and Weber rivers and Cottonwood creek.	14,100	.....	2,600	16,700
Utah-Idaho Sugar Co.	Collinston	Bear river	5,600	.....	.....	5,600
Beaver River Power Co.	Beaver county	Beaver river	4,500	.....	.....	4,500
Logan Municipal Plant	Logan	Logan river	3,600	.....	.....	3,600
Concerns (1) with 1000 but less than 3000 hp.			1,200	.....	.....	1,200
Total			52,700	.....	2,600	55,300
Washington						
Washington Water Power Co.	Spokane and Little Falls	Spokane river	133,000	.....	24,000	157,000
Pacific Coast Power Co.	Electron and Snoqualmie Falls	Puyallup, Snoqualmie, and White rivers.	77,000	.....	53,000	130,000
Seattle Munic. Light & Power Plant.	Cedar Lake	Cedar river	20,800	.....	14,200	35,000
Tacoma Municipal Plant	La Grande	Nisqually river	32,000	.....	.....	32,000
Wenatchee Valley Gas & Elec. Co.	Wenatchee	Entiat river and minor streams	4,730	.....	15,000	19,730
Great Northern Railway Co.	Leavenworth	Wenatchee river	8,000	.....	4,500	12,500
Spokane & Inland Empire R. R.	Near Spokane	Spokane river	12,000	.....	.....	12,000
Whatcom County Ry. & Light Co.	Mount Baker	Nooksack river	3,300	.....	5,000	8,300
American Power & Light Co.	Naches, North Yakima, White Salmon, and Priest rapids.	White Salmon, Columbia, and Naches rivers.	8,080	.....	.....	8,080
Concerns (1) with 1000 but less than 3000 hp.			1,600	.....	.....	1,600
Total			300,510	.....	115,700	416,210

Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Book Reviews

SUBWAYS AND TUNNELS OF NEW YORK. By Gilbert H. Gilbert, Lucius I. Wightman, and W. L. Saunders. John Wiley & Sons, New York. Pp. 372. Index. For sale by the *Mining and Scientific Press*, San Francisco, California. Price $4.

The title is self-explanatory. The work done by engineers in relieving traffic congestion in the over-crowded metropolis is probably without parallel. The greater part of the matter is a reprint of material that has already appeared in the various engineering society proceedings and the technical press, but the authors have performed a genuine service in assembling the published matter and presenting it in book form. A great deal of data on costs is presented which alone is worth the price of the book. A generous amount of space has been given to descriptions of the apparatus used, but no one is disposed to deny to a manufacturer the credit which is his just due for the perfection and successful performance of his apparatus, and the fact that unusual and exceptional conditions were successfully met is worthy of note. Manufacturers generally are generous in giving engineering data, and Mr. Saunders has been conspicuously so in his contribution to the subject matter. The fact that the compilation of the data on this interesting and complex phase of engineering construction was made possible only through private initiative in no way detracts from its value as a reference book.

CONCRETE COSTS. By Frederick W. Taylor and Sanford E. Thompson. John Wiley & Sons, New York. Pp. 692. Index. For sale by the *Mining and Scientific Press*, San Francisco, California. Price $5.

Engineers and contractors in general have a firmly seated objection to giving out information relative to the cost of doing engineering work, and as a rule such cost data as have been published are of little or no value. It has fallen to Messrs. Taylor and Thompson, however, not only to present a most valuable work on this subject, but to have compiled and prepared the necessary data in such a way as to make it comparatively easy for the engineer or engineering-contractor to revise the figures given to comply with individual conditions. The subject matter covers not only the cost of work, but makes many valuable recommendations and suggestions as to the most economical way to obtain the best results. The book covers the approximate costs of miscellaneous concrete work, concrete structures, reinforced concrete buildings, and also the determination of labor cost, task work in construction, proportioning concrete tables of quantities of materials for concrete and mortar, cost of concrete materials, elevating and crushing stone for concrete, handling and transporting materials, hand and mechanical mixing, and labor costs, with tabulated costs and methods for bending and placing steel, costs of forms, and estimates for reinforced concrete construction. This is the most valuable book of its kind that has yet been published and will ultimately prove beyond a doubt to be indispensable among engineering contractors engaged in this class of construction.

REINFORCED CONCRETE BUILDINGS. By Ernest L. Ransome and Alexis Saurbrey. McGraw-Hill Book Co., New York. Pp. 235. Index. For sale by the *Mining and Scientific Press*, San Francisco, California. Price $2.50.

The large number of competing methods for reinforced concrete construction that have come into vogue during the past few years have resulted in a great deal of confusion in the minds of possible users. Mr. Saurbrey presents a history of the development of the use of reinforced concrete since its inception, together with an analysis of the basic patents, which in itself will be of great value to all engineers who desire to possess a thorough understanding of the subject. The rational design of reinforced concrete buildings is extensively dealt with and is treated under the subdivisions of adhesion, compression, and lateral expansion, bending, transverse stresses, applications to the bending theory, initial and allowable stresses. Practical construction is also treated at length, the first subdivision including materials of construction, floor estimates, foundations, finishing operations, fireproofing, and various repairs to existing buildings, accidents, superintendent's specifications, and the theory of beams. The theory and application throughout is comprehensively treated. The book contains many tables and illustrations of construction methods.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Engineering Bonds

*Tax exempt in California.
†Legal investment for savings banks in California.
‡Available as security for deposit of state, county, and municipal funds and postal savings deposits.

THE GREAT WESTERN POWER CO., of New Jersey, has a capitalization of $14,670,000 in common stock, authorized and issued; $6,000,000 in preferred stock; 6% cumulative from January 1, 1912, authorized and issued. This is a holding company only and owns all of the $27,500,000 authorized and issued capital stock of the Great Western Power Co. of California. This latter company has authorized $25,000,000 in first mortgage 5% bonds, $16,538,000 in bonds. Those issued have been certified, including the bonds necessary for the purchase of the City Electric Co. of San Francisco, of which $750,000 does not bear interest and is held by a trustee under a mortgage securing the California Electric Generating Co. bonds as additional security thereto, $611,000 of which is in the treasury of the Great Western Power Co., the total bonds outstanding in the hands of the public being $15,177,000. The California Electric Generating Co. has a total capitalization of $5,000,000 in common stock authorized and issued, all of which is owned by the Great Western Power Co. and deposited with a trustee under a mortgage securing its first mortgage bonds as additional security thereto; preferred stock authorized and issued is $2,500,000, of which $900,000 is held by trustee and may be used only for the benefit of the Great Western Power Co system, leaving outstanding in the hands of the public $1,600,000. Dividends on the stock in the hands of the public are cumulative at the rate of 6% from January 1, 1912, and are guaranteed by the Great Western Power Co. First mortgage 5% bonds have been authorized in an amount of $5,000,000, of which $1,200,000 has been issued. The principal and interest of the bonds outstanding are guaranteed by the Great Western Power Company.

The property of the Generating company is leased to the Great Western Power Co. The City Electric Co. of San Francisco has a capital stock of $5,000,000, of which all but 20 shares have been acquired by the Great Western Power Co. and deposited with trustee under the mortgage securing its first mortgage bonds as additional security thereto. First mortgage 5% bonds have been authorized in an amount of $5,000,000, of which $1,700,000 has been issued. For the twelve months ended May 31, 1911, the earnings of the Great Western Power Co. system operated separately were as follows: Gross earnings $1,947,069; operating expenses, including maintenance and taxes, $749,365; net earnings, $1,197,704; interest paid, $718,671; surplus, $479,033.

THE CENTRAL CALIFORNIA TRACTION CO. has issued first mortgage 5% sinking-fund gold bonds, total amount authorized $1,500,000, due April 1, 1936, in denominations of $1000. Engineering report has been made by J. G. White & Co. The territory served lies between the city of Sacramento and Oak Park. The company also owns and operates lines in the city of Stockton, including the interurban line from Stockton to Lodi. The system connects at both Sacramento and Stockton with river steamers for all points and interchanges freight for Eastern shipments with the Western Pacific, Santa Fe, and Southern Pacific companies. Total mileage in operation is 69. The properties are of high-grade construction throughout; the rails are 75-lb. with gravel ballast; all bridges are of steel or concrete; terminals in the cities of Sacramento, Stockton, and Lodi are adequate for both freight and passengers. The company also owns and operates a machine shop in the suburbs of the city of Stockton. The interurban lines are operated by the under-running three-rail system similar to that in use by the New York Central railroad and other high-class roads in the East. The following figures show the earnings for three months ended November 30, 1910:

Gross earnings	$64,469.48
Operating expenses and maintenance	44,841.05
Net earnings	$19,628.43
Interest on entire bond issue	18,750.00

*SAN JOAQUIN COUNTY has issued 5% highway bonds, total amount $250,000, dated July 1, 1909, maturing serially July 1, 1912-49. These are coupon bonds in denominations of $1000, interest payable semi-annually. The assessed valuation in 1911 was $47,624,614. The total bonded indebtedness, including this issue, is $1,640,000; estimated population is 60,000.

Generated on 2024-09-29 23:48 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Engineering News

Irrigation and Water Supply

San Francisco.—A group of men headed by Tilden Tognazzini, of the Swiss-American Bank, and the Fleishhacker Bros. have purchased 24,000 acres of land in Siskiyou county at a price of $400,000. This tract of land is to be subdivided into 160-acre farms, each farm is to be equipped with an individual pumping station for furnishing water for irrigation purposes; power will be furnished for driving the pumps electrically by the Siskiyou Light & Power Co.—The Board of Army Engineers which will report to the Secretary of the Interior on the Hetch-Hetchy water project, is expected in San Francisco about the middle of July. John R. Freeman is consulting engineer representing the city of San Francisco.

Stockton.—Louis Titus, of San Francisco, is said to have purchased the Trahune ranch of 6000 acres; levees will be built and the land will be reclaimed for farming purposes.

Merced.—The Union Colonization Co. has purchased the Chowchilla ranch for $2,000,000; 108,000 acres is involved in this transaction. The land is to be subdivided into small farms, and pumping plants will be built for furnishing water for irrigation.

Los Angeles.—The Southern California Utilities Co. has filed application to the Railroad Commission for permission to issue bonds in the sum of $10,000,000. The company's headquarters are at Riverside. Water is to be developed to supply a 30,000-acre tract in Riverside county. It is stated that options are held on the properties of the Roma Power & Irrigation Co., the Lake Hemet Water Co., the Fairview Land & Water Co., the Hemet Land Co., and the Hemet Town Water Co.; $4,700,000 will be spent on new construction.

Sacramento.—The Natomas Consolidated Co. is preparing to place 90,000 acres in cultivation in the vicinity of this city; levees are to be built, and pumps are to be installed for furnishing water for irrigation.

Portola (Plumas county).—The Portola Land & Improvement Co. will erect new water-works. A pipe-line is to be built from Grizzly to Portola.

Oroville.—The Feather River Canal Co., of this city, S. J. Norris, president, has commenced work on its main canal. A pumping plant is to be constructed and laterals to be built for the purpose of irrigating between 150,000 and 200,000 acres.

Alturas (Modoc county).—C. M. McKendree, W. Lair Thompson, E. S. Berney, and E. M. Brattain are organizing a ditch company to tap Goose lake for the purpose of furnishing a supply of water for irrigating 50,000 acres of land in this vicinity.

Klamath Falls, Oregon.—Specifications are ready for bidders at the local office of the United States Reclamation Service for construction work necessary for the building of the second unit from Poe valley lateral of the Klamath project. Bids will be opened August 1.

Reclamation

According to the *Reclamation Record* for May, the condition of the U. S. R. S. projects was as follows. *Arizona.*—Salt River project, 93.5% completed. *Arizona-California.*—Yuma project, 71.4% completed; Oakland project, 84 completed. *Colorado.*—Grand Valley, preliminary work; Uncompahgre Valley project, 53.8% completed. *Idaho.*—Boise project (exclusive of Arrow Rock reservoir), 93% completed; Arrow Rock reservoir, 18% completed. *Idaho.*—Minidoka project (gravity unit), 88.5% completed; South Side pumping unit, 91% completed. *Montana.*—Blackfeet (Two Medicine unit), 58.5% completed; Badger-Fisher unit, 10.8% completed; Flathead project (Jocko division), 84% completed; Mission division, 11.6 completed; Pablo division, 33.5% completed; Polson division, 9.9% completed; post division, 34.7% completed; Fort Peck project, no work during month; Huntley project, 96% completed; Milk River project, 12% completed; Sun River project, 8.5% completed; Fort Shaw unit completed. *Montana-North Dakota.*—Lower Yellowstone project, 95% completed. *Nebraska-Wyoming.*—North Platte project, 81% completed. *Nevada.*—Truckee-Carson project, 66.5% completed. *New Mexico.*—Carlsbad project, completed; Hondo project, completed. *New Mexico-Texas.*—Rio Grande project (storage unit preliminary work); Leasburg unit, completed. *North Dakota.*—Missouri River Pumping project (Buford-Trenton unit, 38% completed); Williston unit, 64% completed. *Oregon.*—Umatilla project, 80% completed. *South Dakota.*—Belle

Generated on 2024-09-29 23:55 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Fourche project, 93% completed. *Utah.*—Strawberry Valley project, 59% completed. *Washington.*—Okanogan project completed; Yakima project, storage unit 16% completed, Sunnyside unit 91% completed, Tieton unit not reported. *Wyoming.*—Shoshone project, 49.7% completed.

Railways

San Francisco.—The Southern Pacific company will make extensive improvements on Long Wharf near the Oakland mole. A new freight shed is to be built. The report of the Western Pacific railroad for April is as follows:

	April, 1912.
	1912. April 30.
Operating revenue	$443,843
Operating expenses	338,096
Net operating revenue	$105,747
Total net revenue	103,081
Taxes	15,957
Operating income	$87,124

It is stated that the Western Pacific Co. will build a branch line from Gerlach, Nevada, to Ft. Bidwell, California. The Ocean Shore Railroad Co. has applied to the State Railroad Commission for authority to issue $700,000 in bonds; these bonds are to be used as security for a loan of $250,000 to provide funds for the purchase of terminal facilities in San Francisco.

Bakersfield.—The Southern Pacific company is making plans for double-tracking its line between this city and Mohave. Changes of route are contemplated in order to rectify the steep grades and sharp curves. The new road will be 17 miles longer than the old one, but the gradients will be much less.

Redding.—The Afterthought Copper Co. has filed a deed of trust for $800,000. Bonds are to be issued for the purpose of furnishing funds for the construction of a standard-gauge railroad from the Southern Pacific line to the company's mine and smelter at Ingot, 28 miles east of Redding. It is stated that the Anderson-Bella Vista railroad will be purchased and will form a part of the new line.

Salem, Oregon.—The Oregon Eastern Railroad Co. has been dissolved, its various properties having been transferred to the Oregon & Washington Railroad & Navigation Company.

Reno, Nevada.—The construction work double-tracking the Southern Pacific line from Ware eastward has commenced. Palmer, McBride & Quayle have taken the contract for the construction of the first three miles of the new work. C. L. Edwards is superintendent of construction.

Denver, Colo.—The Denver & Rio Grande railroad will purchase 40 passenger and freight locomotives and will re-lay 55 miles of road with 85-lb. rail. It will also build 20 miles of second track, the amount to be expended in all is approximately $10,000,000. A project is being contemplated for the electrification of the road over Soldier Summit.

Los Angeles.—The Los Angeles, San Pedro & Salt Lake railroad will lay 41,000 tons of new 75-lb. rail on the Provo division.

Miscellaneous Engineering Construction

San Francisco.—Contract for the completion of the section of the North Point main sewer at Second and Sansome streets has been awarded to the Daniel Construction Co. at a price of $81,303.45. This is the third company to attempt to complete this work, the Keystone Construction Co. and J. F. Van Loben having failed in their attempt. Contract for the new Western Pacific dock has been awarded to Jenkins & Wells, contract price being $10,000. The Ross Construction Co. has completed the foundation.

Oakland.—The soundings have been made for the proposed subway under the Oakland estuary to connect Oakland and Alameda.

Sacramento.—A bond election will be held on July 23 for the purpose of authorizing an issue of $887,000 for the construction of a by-pass above the city for the purpose of flood control. George N. Randle is city engineer. The Western Pacific railroad is employing a force of men for the purpose of completing its repair shops, construction work on which having been stopped over a year ago.

Richmond.—A bond issue of $1,000,000 is contemplated for harbor improvements.

Los Angeles.—The Indian Refining Co. will build a temporary wharf inside of the breakwater to be used for unloading the Asiatic

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Petroleum Co.'s steamers exclusively. Concrete wharf construction is contemplated at San Pedro harbor. E. P. Goodrich is consulting engineer. The Los Angeles railway is contemplating boring a tunnel through the Broadway hill, parallel to the present tunnel. It is stated that necessary authority has been received and work will commence within a short time.

Venice.—Franchise is to be sold on July 8 for the construction of the largest pier on the Pacific coast. Augustus Stutzer has prepared plans for the structure, projecting 1000 ft. into the ocean and 700 ft. wide. Reinforced concrete will be used. Total estimated cost is $175,000.

San Diego.—Bids have been received for the construction of a pier bulkhead and bridge work for the improvement of San Diego harbor. Total amount to be spent will be in excess of $700,000. E. M. Capps is harbor engineer.

Panama Canal

The first test of lock-gate air-chambers took place on June 10, when the air-chambers of the West leaf of the upper guard gate in the East chamber of Gatun lock was tested by filling it with water. The test was highly satisfactory, the leakage being very small and easily remedied. The air-chamber of this leaf contains 13,000 cu. ft. An extensive dump made during the French excavation, 200 ft. long and varying in width from 20 ft. at station 1740 to 300 ft. at station 1750 and 30 ft. high, is to be removed in order to prevent additional slides in Culebra cut. In all, 7745½ cu. yd. of concrete was placed in the walls of Gatun lock during the month of May. This is the smallest amount placed during any month since the work commenced in August, 1909. Only two of the eight Chicago cube mixers were employed, and these were not in continuous use. The walls of the locks proper are finished except for placing small quantities of concrete in tunnel construction and for grouting machinery. The concrete work in the spillway of Gatun dam is over 89% completed, 201,119 cu. yd. out of the total of 225,000 having been placed by close of work on June 8. Two of the centrifugal hydraulic pressure pumps are being transferred to the east side of the lagoon in preparation for the hydraulic excavation of the canal channel for the section between the Aqua Dulce pressure plant and the dike a mile south. The material excavated will be forced through pipe-lines under the sand-track to the flats which are to be reclaimed between the river and the Panama railroad.

Canal excavation for the month of May is summarized below:

Locality.	'Work' excavation, cu. yd.	'Plant' excavation, cu. yd.	Total excavation, cu. yd.
Atlantic Division			
Dry excavation—			
Locks, dam, and spillway	.....	.....	.....
Mindi	27,134	.....	27,134
Total	27,134	.....	27,134
Wet excavation—			
Atlantic entrance	229,626	2,847	232,473
Locks, dam, and spillway	200,530	.....	200,530
East diversion	.....	.....	.....
Total	430,156	2,847	433,003
Total wet and dry excavation	457,290	2,847	460,137
Central Division			
Dry excavation—			
Culebra cut	1,405,760	.....	1,405,760
Chagres section	12,524	.....	12,524
Obispo diversion	.....	.....	.....
Total	1,418,284	.....	1,418,284
Pacific Division			
Dry excavation—			
Locks, dams, and spillways	39,114	.....	39,114
Diversions	.....	.....	.....
Prism, south of Pedro Miguel locks	140,163	.....	140,163
Total	179,277	.....	179,277
Wet excavation—			
Pacific entrance	388,310	60,908	449,218
Miraflores locks	.....	.....	.....
Diversions	.....	.....	.....
Total	388,310	60,908	449,218
Total wet and dry excavation	567,587	60,908	628,495

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

TOTAL CANAL EXCAVATION

Dry excavation...	1,624,695	.....	1,624,695
Wet excavation....	818,466	63,755	882,221
Total	2,443,161	63,755	2,506,916

Dam and lock construction was as follows:

DAM AND LOCK CONSTRUCTION

MATERIAL.	Atlantic, cu. yd.	Pacific. cu. yd.	Total, cu. yd.
Concrete laid in locks	7,746	102,831	110,577
Concrete laid in dams and spillways.....	1,920	.....	1,920
Fill placed in dams..	421,750	53,002	474,752

Power, Gas, and Electricity

San Francisco.—The Central California Gas Co. has been granted permission by the State Railroad Commission to issue $33,000 worth of bonds to be expended for the construction of a gas plant at Lindsay, purchase of the Home Gas Co.'s plant at Porterville, and also for laying a gas main connecting Lindsay, Porterville, and Exeter.

Los Angeles.—The Southern Counties Gas Co. has petitioned the State Railroad Commission for authority to issue bonds to the amount of $443,000; the funds acquired are to be used for the extension of the field of operations of the company and for the purchase of gas plant and distributing system in Pomona, and a pipe-line and distributing system in Claremont, Lordsburg, and San Dimas for the Southern California Edison Co. at a purchase price of $400,000.

Colfax.—The Independent Power & Light Co. has been formed for the purpose of serving neighboring towns with light. An independent pole and wire system is to be constructed and a 200-hp. gas-engine driven generating plant will be installed. The Colfax Suburban Telephone Co. is said to be interested in this project.

Petroleum

San Francisco.—The Standard Oil Co. of California will increase its capital stock from $25,000,000 to $50,000,000. In 1911 the net profits of the Standard company on business in this state were $3,141,625.85.—The Lubricating Products Co. has been organized by Henry J. Crocker, L. A. Phillips, J. M. O'Brien, J. H. Bending, and A. Wissitch. Lubricating oils and compounds will be manufactured at a factory to be built near Ravenswood in Santa Clara county. —Suit has been commenced by the United States Government in the Federal courts against the Southern Pacific Co., involving land grants in the Elk Hills valued at $15,000,000.—The Interstate Commerce Commission at Washington, D. C., has decided that pipe-lines are common carriers when engaged in interstate commerce, even though such lines are operated over private rights-of-way and transport their own oil only.

Santa Barbara.—Robert B. Canfield, of Santa Barbara has sold oil and mineral rights to 5175 acres of land in the vicinity of Los Olivos to a company headed by Rudolph Spreckels of San Francisco.

Los Angeles.—The Columbia Oil Producing Co. has acquired the properties of the Puente, Orange, and Pico Oil companies and will reorganize on the basis of a capital stock of $3,500,000. The officers of the new company are W. D. Scott, William R. Rowland, M. H. Sherman, Chester W. Brown, W. L. Stewart, Frank Pfaffinger, and Harry Chandler, all of Los Angeles. It is stated that the Union Oil Co. is interested in this transaction. The merger controls 5000 acres of oil land in the Fullerton field, all of which is practically proven ground. The General Petroleum Co. has been granted a right by the United States Government to lay its pipe-line 3600 ft. along the San Pedro breakwater. The company also has permission to erect two 55,000-bbl. steel tanks. The General Pipe-Line Co. has obtained the franchise required for its right of way and expects to commence pipe laying on July 1.

Bakersfield.—The Associated Oil Co. is reported to have brought in a 50,000-bbl. gusher in the Elk Hills property on June 13. The well is 2800 ft. deep. The oil is said to be 23 gravity and lighter.

Tampico, Mexico.—The Mexican Eagle Oil Co. will build a pipe-line 112 miles long to its property south of Tampico and is also planning to build a refinery at that point.

Avon.—The Associated Oil Co. has commenced the construction of a million barrel resevoir at this point.

Following are the stocks on hand May 31:

	Field.	Pipe-line.	Total.
Totals	2,504,972	41,786,451	44,291,423

The gross production of petroleum of the state for May was 7,304,319 bbl. The follow-

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ing is the report of the net production after deducting the fuel used in the field:

San Joaquin Valley	May. Bbl.	April. Bbl.
Coalinga	1,606,687	1,544,897
Kern River	947,117	930,482
McKittrick	501,936	461,267
Sunset-Maricopa	441,494	449,846
Midway	1,885,349	1,934,387
Lost Hills	112,136	105,241
Total	5,494,719	5,426,120
Coast Regions		
Santa Maria, Lompoc, and Cat Canyon	431,012	439,332
Summerland	4,350	4,350
Total	435,362	443,682
Southern Fields		
Fullerton-Puente	481,292	484,574
Salt Lake-Sherman	232,005	224,537
Los Angeles City	31,842	31,842
Whittier	61,853	56,689
Coyote-La Habra	84,732	79,926
Newhall	9,922	9,990
Ventura county	50,301	43,593
Total	951,947	941,151
Grand total	6,882,028	6,810,953

The Government's report for May shows that oil exports were the second largest during May and during the eleven months preceding May 31, cotton coming first. The following are the data:

	May 1911.	May 1912.
Illuminating oil, gal.	97,929,820	107,246,695
Illuminating oil, dol.	5,501,236	6,791,727
Lubricating oil, gal.	12,266,988	21,207,259
Lubricating oil, dol.	1,604,046	2,576,256
Naphthas, gal.	12,570,231	20,803,521
Napthas, dol.	1,009,737	2,000,000
Crude mineral oil, gal.	8,813,408	6,011,240
Crude mineral oil, dol.	253,842	298,780
Mineral oils, gal.	136,364,528	177,343,826
Mineral oil, dol.	8,517,140	12,174,861

EASTERN PRODUCTION

The receipts of petroleum from the wells in May, by the pipe-lines of the Pennsylvania, Lima, and Kentucky fields, according to the *Oil City Derrick*, which makes regular monthly reports, aggregated 2,638,288.23 bbl., an average of 85,106 bbl. per day. This amount was 162,858 bbl. more than in April, and the daily average increase was 2591 bbl. In May 1912 the daily average runs were 82,608 bbl. The increase comes from all the principal divisions, the Pennsylvania fields adding 5000 bbl. in round numbers, West Virginia and southeastern Ohio 138,000 bbl., Lima 20,000, and Kentucky 8000 bbl. The total receipts of all lines included in the report amounted to 7,402,321 bbl. for May, a daily average of 238,784 barrels.

Deliveries by the Eastern lines in May amounted to 7,520,630 bbl., and a daily average of 236,149 bbl. In April the deliveries by the same lines were 5,984,488 bbl. and a daily average of 199,483 bbl. The deliveries by the Illinois lines were 1,501,887 bbl., a decrease from the previous month of 72,541 bbl. The shipments by the Prairie Oil & Gas Co. were 2,816,066 bbl., a decrease of about 9000 from April.

The following table shows the amount of the various grades of oil held by the several pipe-lines in the different divisions of the oilfields at the close of business May 31, 1912:

Grade of oil.	Barrels.
Pennsylvania	4,233,146.02
Lima	2,494,149.13
Kentucky	295,839.10
Illinois (Eastern lines)	2,012,144.35
Illinois (Ohio Oil Co.)	16,636,328.76
Kansas (Eastern lines)	2,585,496.77
Kansas (Prairie Oil & Gas Co.)	40,094,613.83
Total May 31	68,351,717.96
Total April 30	68,754,601.93
Decrease	402,833.97

FOREIGN STATISTICS

Great Britain and Ireland imported during the first four months of 1912, 113,788,500 gal. of petroleum and products, of which 65% came from the United States.

Rumania's production for the first quarter of 1912 was 540,375 tons of crude, which, at the rate of seven barrels per ton, is equal to 2,282,625 bbl., or a daily average for 91 days of 25,083, which, if continued for 366 days, will make the year's output 9,180,667 bbl., during 1911 and 9,466,023 in 1910. Of this output, 9,830,821 bbl. was refined in 1911, during 1910, 7,507,093 bbl. There were consumed as fuel at the refineries 861,203 bbl. in 1911 and 758,891 in 1910.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Markets

MATERIALS FOR CONSTRUCTION

(San Francisco prices, June 29.)

Shapes—Angles, tees, and channels, 3 in. and under, $2.40 per 100 lb.; over 3 in., $2.25 per 100 lb.; I-beam, 4 in. to 15 in., $2.35 per 100 lb.

Bar Steel—Rounds and squares, $2.30 base per 100 lb.

Wire Nails—$2.55 base per 100 lb.

Black Sheet Steel—No. 18-20, $3.45; No. 22-24, $3.50; No. 26, $3.55; No. 27, $3.60; No. 28, $3.65; No. 30, $3.85.

Steel Plates—No. 16, $2.85; No. 14, $2.75; No. 12, $2.70; No. 8, $2.40; No. 10, $2.55; 3/16, $2.35; ¼ in. and heavier, $2.25; all per 100 lb.

Rails—Steel T, 8-lb., $2.15; 12-lb., $2.05; 16-lb., 20-lb., and 30-lb., $2.

Pig Iron—No. 1 Scotch, $25.00 to $27.50.

Coke—German Syndicate, forked foundry, $14 to $15 per long ton; average to arrive ex-ship, $14 to $15 per long ton.

Portland Cement—In sacks, $2.20 per bbl.

Lime—$1.25.

Fire-Brick—Imported Carr, Cowen, or Snowball, $50 per 1000; domestic Livermore, $35 per 1000.

Fire-Clay—$10 per ton.

OIL SHARES

(By courtesy of San Francisco Stock Exchange, June 29.)

	Bid.	Ask.		Bid.	Ask.
Assd Oil	43.00	..	New Pa Pet	..	.50
Caribou	.91	..	Paraffine	.50	..
Claremont	.65	..	Palmer	.53	..
Coal Natl	.21	..	Premier	..	.50
De Luxe	.80	..	Republic	.32	..
Empire	1.25	..	S F & McK	12.37	15.00
Maricopa 36	.61	..	Section 25	21.00	..
McKittk	.09	..	Silver Tip	.90	.95
Monte Cristo	1.30	..	S W & B	.20	.25
Natl Pac	.03	.05	Turner	.87	1.00
Nev County	.05	..			

CALIFORNIA OIL DIVIDENDS FOR MAY.

For May the total dividends of all California companies, listed and unlisted, operating both in the state and in Mexico, were $1,021,068.56, as follows:

Amalgamated	$1.00	$100,000.00
Caribou	0.025	8,070.30
Central	0.015	15,400.00
Claremont	0.015	7,500.00
Columbia	0.01	9,992.26
Del Rey	0.005	3,500.00
Fullerton	0.05	30,000.00
Home	0.015	7,500.00
Homestake	0.10	1,000.00
Monte Cristo	0.025	12,500.00
Mount Diablo	..	5,000.00
New Pennsylvania	0.005	2,500.00
Paraffine	0.01	3,000.00
Record	0.01	10,000.00
Rice Ranch	0.015	4,500.00
San. Fran. & McKittrick	0.10	5,000.00
Sauer Dough	0.02	4,000.00
Section 25	0.50	20,000.00
State Consolidated	0.005	5,000.00
Traders	0.006	9,000.00
Union	0.006	183,387.50
Union Provident	0.006	90,767.60
United Petroleum	0.006	48,450.60
Western Union	0.01	10,000.00
W. K.	0.03	15,000.00
Total Cal. companies		$621,068.56
Mexican Pet., Ltd., pfd	0.002-3	80,000.00
do common	0.01	320,000.00
Total all companies		$1,021,068.56

SAN FRANCISCO QUOTATIONS.

(San Francisco Stock & Bond Exchange June 29.)

LISTED

	Bid.	Ask.		Bid.	Ask.
Assd Oil 5	102	102½	Oro Elec 6	97¾	98
Bay C P 5	..	101¾	Pac Gs I 4	89	..
C C G&E 5	101¾	103¼	Pac G&E 5	..	92
C E ser A 5	87½	..	Pac E R 5	..	104½
C G & E 5	101⅞	..	Pac L & P 5	96¾	97½
do Un 5	96	..	do gtd 5	98½	..
Cal st Ca 5	102	..	Pac T&T 5	100	100⅜
Cen C T 5	95	95½	P & C H 6	..	100½
City El 5	..	89¼	P & O R 6	100	..
C C Wat 5	..	100	Peo Wat 5	75	..
do g m 5	94⅞	..	S E G&R 5	103	..
E E L A 5	102	..	S D & Cy 5	97½	..
E L & P 6	105	..	S J L&P 5	99¼	..
F & C H 6	100	100½	do serA 6	101	102
Gt W Pr 5	88	88½	S F E R 5	..	90
H R T&L 6	105½	..	SFN&CR 6	102	..
L Bch Gs 6	100	..	SFO&SJ 5	104⅞	..
Ls An E 5	..	102	do 2m 5	..	97
L A G&E 5	99¾	..	do Con 5	93¼	..
do Corp 5	98¼	..	SJ&SC 4½	..	88
Ls An R 5	107¼	..	S B G&E 6	100	..
do Corp 5	96½	97½	S R of C 6	..	102
L A Lt g 5	100	..	S P 1c g 5	111¾	113¾
L A-P 1c 5	104	..	S P Br C 6	126	126¾
L A-P C 5	..	100¼	SP 1st ref 4	..	95
Mar W&P 5	..	100	S V g m 4	93½	..
Mkt st Ca 6	..	100¼	U G & E 5	..	101
do 1c m 5	..	92	U R S F 4	..	67
M C G&E 6	99½	..	Val C P 5	100⅜	..
MV& MT 5	100	..	Water Stocks—		
Nat Con 6	93¾	..	Marin Co	53½	..
N R of C 5	112¾	..	Peo W pfd	50¼	52
N Cal R 5	106½	..	Spg Val	62	62½
N Cal Pr 5	..	101	Gas & Elec Stocks—		
do Con 5	..	94	NCal Pr Cn	..	50
N Elec 5	..	94½	Oro El pfd	..	76
O G L&H 5	100	102½	do com	17	..
Oak Tra 6	107	..	Oro Wat	100	..
do 5	..	105½	Pac Lt pfd	..	75¼
do Con 5	102¼	..	do com	79½	81
Oak Tr c 5	..	98	Street R R Stocks—		
do 5	90	90¾	California	124¼	..
Oak W g 5	95	..	Presidio	..	..
Om Ca R 6	101	..	SF-OT A pf	..	87½

UNLISTED

	Bid.	Ask.		Bid.	Ask.
Am RivE5	95	..	NB D O M	300	350
Atl Cem	..	50	N P C R 5	99⅞	100¼
AsdOil1st rf	..	92½	N W Elec	8	20
Bay C P 5	103½	104½	Oahu R R	152½	..
BlueLW 5	102½	..	Oak C R	..	20
BenWC 5	..	103	Oak Tr pfd	80	..
CC G&E 5	92	..	do com	30	40
CalEgen 5	87¾	..	Oak RR 6	100½	..
do pfd	70	..	Oak & ARy	20	25
C&NW 5	104	104¾	do 5	80	82¾
Concrd Cl 5	..	65	OWL & P 6	..	101¼
C C L&P	..	85	Pac P Cem	..	77½
C G Pr bds	92¾	93	do 5	..	101½
do 5	91	91¾	Pac S Sec	..	¾
do 5	91	91¾	Pac S Co	..	135
E S W 5	..	100	Peo W com	2⅝	3¼
Ewa E S	34	34½	Pet & S RR	94½	..
Esper Oil 6	..	82½	do stock	..	25
Gas Con As	..	29	River Cem	41	..
Gt W pfd	61¼	..	SF&SJV5	110	111
do com	33	35½	SF&NP 5	..	104¾
Gen Pet	17	..	S P C R 5	92	..
HuntL&I6	100	103	Std Pt Cem	18½	22½
Kern L Co	180	..	do 6	..	90
Keswk c 6	..	102½	S F G & C	..	15
Key R pfd	83	..	SF G&E4½	..	93¼
do com	..	29	do n c 4½	..	93¼
Lt L&P bds	65½	..	do c 5	..	94¾
do com	..	80½	S J Wat	105	..
L&P G C 6	..	98	S C Pt Cem	41	..
do Dev 5	60	..	do 6	..	90½
L & A Ry	99	104¾	S Yuba 5	..	108½
Met Gas 5	94	99	Std El c 5	92	..
Mut El 5	97	..	Sutter St 6	..	98
MW P & E	101½	..	Turlock Ir	..	95
Nat Con	14	..	West Pac	9	..
do 2	71	..	do 5	84¾	85½
Nat D Co 6	..	101	West Am R	10⅛	..
Nat I C S	50	..	West P C	31	35
Nat L&M 6	..	101	do pfd	..	61

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Company Reports

Great Falls Power Co.—Stone & Webster Corporation, engineers, have made a report on the property of the Great Falls Power Co. to the Guaranty Trust Co. of New York, as a basis upon which the recent issue of bonds was underwritten. The report states that the Great Falls Power Co. was organized in May 1910 to take over the water-powers, transmission lines, and the power business of the Great Falls Water Power & Townsite Co. The latter company had for some time held a large amount of real estate in and about Great Falls and had acquired the greater part of the water and riparian rights as well as abutting property which will be required for the development of a series of rapids and falls on the Missouri river from Black Eagle falls to Sheep creek, a distance of about 12 miles in which the river drops a total of 460 ft. Developments had been made at Black Eagle falls and at Rainbow falls, and transmission lines to Butte and Anaconda, with sub-stations in these two cities, had also been built. The Power company is now said to own all rights and abutting property necessary for the full development of the fall as outlined above. The possible sites are: Black Eagle, 45-ft. head developed; Rainbow, 110-ft. head developed; Power 'B,' 56-ft. head, undeveloped; Great Falls, 172-ft. head, undeveloped; Power 'E,' 70-ft. head, undeveloped.

The minimum flow at Black Eagle falls is about 2150 sec. ft., except for very short periods of time on infrequent days, when the flow is likely to be somewhat less than this figure. As the operating head is practically 45 ft., a total of 11,000 water horse-power can be relied upon. The dam at Black Eagle is of timber-crib construction. It appears to have been substantially constructed and it is perfectly safe to estimate its life at a minimum of 50 years. The Power company sells water to the Great Falls smelter equivalent to between 5000 and 8000 hp., depending on the flow of the river, this power being used by the smelter to develop electric current and for the operation of blowers. The Great Falls Electric properties takes water equivalent to 1000 hp., which is used in the generation of electricity. The Power company has placed one wheel at the Black Eagle site which generates 300 hp., this power being sold to the Royal Milling Co. as mechanical energy which is delivered by a rope drive. It will be seen that the total primary power of the Black Eagle plant is already sold, although any increase in the minimum flow of the river caused by improvements in storage at the head-waters and by operations of existing storage basins on the river under a single control will increase the power available at this point. The approximate cost of the Black Eagle dam is $515,000.

The Rainbow development has a head of about 110 ft. The minimum flow is about 2300 sec. ft., except for very short intervals at infrequent periods. The plant output corresponding to this flow would be substantially 16,000 kw. By taking advantage of the natural fall of the river the head of 100 ft. is secured by the construction of a dam only 29 ft. high. This dam is a timber-crib structure ballasted with rock and concrete. The conditions under which the dam was built were favorable and the structure is substantial and adequate in every respect. Its life should be considerably in excess of 50 years, and during that period nothing but replacement of more or less of the surface-timbers need be expected. The flow is diverted by this dam into two steel penstocks, 2400 ft. long and 15½ ft. diam. to the forebay of the power-house. This forebay is a basin of approximately 1½ acres area and from which are led twelve 8-ft. steel penstocks which carry the water to six pairs of wheels aggregating 36,000 hp. in capacity. The six generators aggregate 21,000 kw. Only 14,400 kw. of transformers has at present been installed and the output of the plant has sometimes been limited by the capacity of its transformers. It is understood that additional transformers are to be installed this year. These transformers raise the voltage of transmission to 102,000. The report for January 1912 shows that of the 17,874 average kilowatts generated, 2305 kw. was delivered from the Great Falls sub-station to the Great Falls smelter and Great Falls electric properties, 8205 kw. through the Butte sub-station, and 5590 kw. through the Anaconda sub-station, making a total distributed of 16,106 kw. The Rainbow dam and power-house cost approximately $2,364,000. There is a growing market for power, and this company enjoys an especially favorable position for furnishing large amounts of power to the best advantage.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

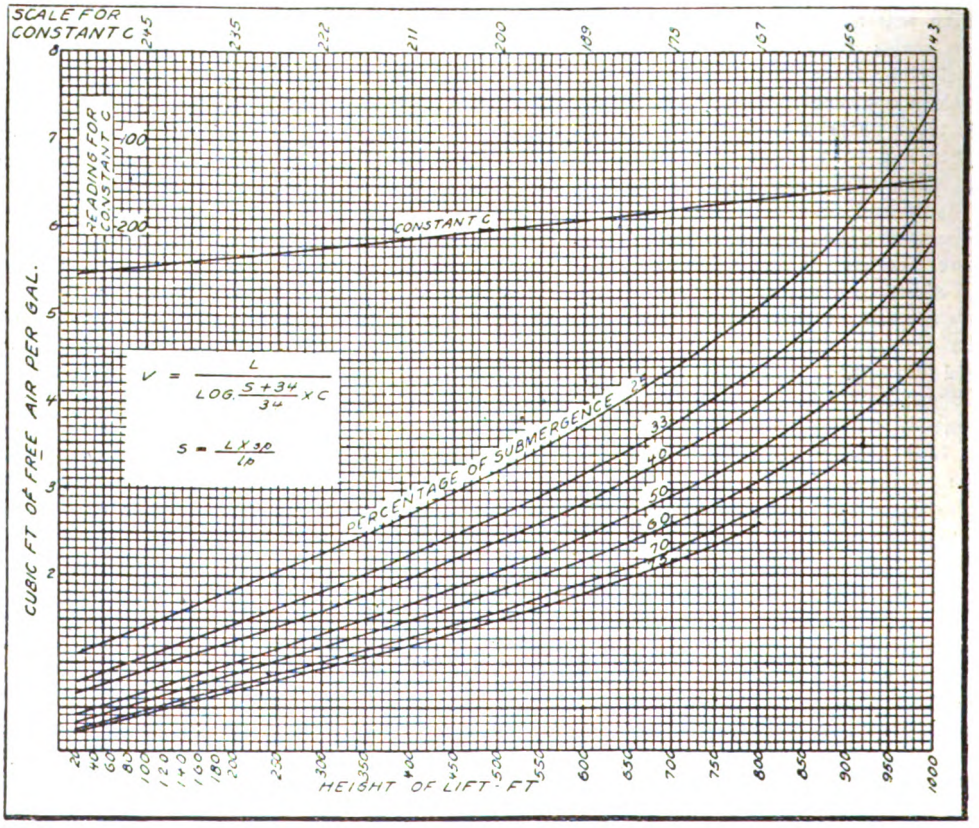
Engineers' Note Book

IN a discussion of the air-lift in the *Compressed Air Magazine* for May 1912, Frank Richards states that where

V = volume of free air in cu. ft. per min.
L = lift in feet
C = a constant 234
S = actual submergence in feet
Sp = percentage of submergence
Lp = percentage of lift

$$V = \frac{L}{\text{Log.}\ \frac{S+34}{34} \times C}$$

$$S = \frac{L \times Sp}{Lp}$$



SCHUMACHER'S rule for the correction of barometer to temperature may be stated:

B = Reading on barometer in inches.
m = Expansion in volume of mercury for 1° F. = 0.0001001.
t = Temperature of the mercury and scale.
s = Expansion of the brass scale in length for 1°F. = 0.00010434, the normal temperature being 62°, then

$$B\frac{m(t-32°)-s(t-62°)}{1+m(t-32°)} = \text{correction to be subtracted.}$$

Air expands $\frac{1}{491.13}$ for every increase of 1° F. Divide difference in inches in readings of barometer by 0.0011, for difference in elevation in feet.

ACCORDING to C. G. DeLaval, the law of proportionality and slip, for water turbines and centrifugal pumps would be expressed in formulæ where

N = number of revolutions per minute.
Q = capacity.
H = total head.
HP = horse-power.

$$\frac{N}{N_1} = \frac{Q}{Q_1} = \sqrt{\frac{H}{H_1}} \text{ or } \sqrt[3]{\frac{HP}{HP_1}}$$

Generated on 2024-09-29 23:46 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Industrial Progress

Fundamentals of Good Roads

By P. W. ROCHESTER

We will never have a system of permanent highways worthy of the name until we have adopted a standard looking to absolute permanence. In any class of construction work we must start with a proper foundation. It is all very well to aim at cheapness, but we should not continue experiments on construction methods that have proved their unfitness.

Who would think of using bitumen for the foundation of a house? What would you think of an engineer who would specify asphaltum for a bridge pier? How long would you retain an employee who would build an engine base of macadam? It is only a question of time before we, on this coast, will inform ourselves on the state of the art and adopt as a standard, portland cement concrete for the base or foundation at least, of all roadways and pavements that are built for permanence.

Every citizen is interested in good roads. No state or country has ever reached a high state of civilization or been blessed with the highest type of citizenship that did not possess adequate means of transportation. We are laboring with the problems of interior development, and the concentration of population in the cities. No one thing will do more to popularize and populate our rural vicinities than a network of highways by which social and commercial intercourse will be promoted. We must make our farm life inviting if we would attract and develop a high grade of citizenship. We have modern means of transportation, but it is ineffective without adequate roads. Every taxpayer and every voter is vitally interested in the improvement of roads. In the long run both road-making and road-maintaining becomes a general tax, and one that we must all pay, directly or indirectly. Not only must we all pay the tax for roads, but, in addition, we all pay the 'mud' tax for not having a gen-

BUILDING A CONCRETE ROAD.

Generated on 2024-09-29 23:44 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

eral system of improved roads. Every railroad materially enhances the value of all contiguous realty and every mile of good permanent roadway adds more than its cost to the surrounding property. The modern development syndicate does not think of offering for sale a suburban subdivision until the streets are paved, and, if it should, it would not invite a class of buyers that would cause the rapid development of the tract.

this result. King county, Washington, has paid dearly to learn this, and a number of California counties have expended immense sums in bituminous base experiments that could have been put into concrete to much better advantage.

California is just undertaking one of her first pieces of standard roadway with a concrete base. A number of counties in Washington, Idaho, Utah, and Oregon are building, or have built, concrete roads of various types, and in no instance have they abandoned concrete after one trial. In several instances plain concrete has been employed, although concrete base with brick, sheet asphalt, bituminous concrete, or a thin coating of coal tar have been used in a number of places.

A FINISHED ROAD.

The demand for improved roadway conditions is taking a mighty hold on the entire country, and our best thought is being called for to determine the type of construction that will prove itself most economical. The economics of the question is in reality the vital phase. We will not build roads for sentiment nor esthetics, but we must spend our money to the best advantage. First cost and upkeep must take an equal place with practicability and efficiency. You can not get the highest efficiency out of any class of wearing surface unless you have a rigid permanent base, and nothing but portland cement concrete will accomplish

The first cost of a permanent hard-surface road with a portland cement concrete base and a bituminous wearing surface will probably be about $1.25 per square yard. To this should be added an average amount of at least 50c. per square yard for grading, drainage, surveying, and overhead. Of this

Generated on 2024-09-29 23:45 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

amount, less than one-fifth would be expended for cement, the ingredient that adds permanence to the entire pavement.

About fifty per cent of the aggregate (crushed rock, gravel, and sand) is saved, or can be dispensed with, if cement is employed. A 6-in. portland-cement concrete slab on a good subsoil will carry any load, whereas it is common practice to lay a macadam road from 8 to 12 in. thick. The up-keep and sprinkling costs of maintaining macadam and oiled roads make a bill that is a great and continuous burden. While these costs can not be entirely eliminated, they can be greatly reduced by building right, from the start. The money saved from the up-keep of a cheap road will more than pay the interest on the excess of first cost of a model road, and it would provide as well a sinking fund to restore the extra amount originally expended. We rarely read a live periodical these days without seeing some strong editorial favoring good roads. I quote the following from a recent number of the Boston *Monitor*; it puts excellently the chief points:

"One can easily imagine how greatly the adoption of a general system of permanent highways would facilitate the handling of light traffic in all localities of Canada and the United States; what a wonderful aid it would be to the handling of post parcels; how it would reduce the transportation rates upon farm products; what a marvelous effect it would have on the present high cost of living.

"There is really no reason why the problem of distribution should not be solved in this way, and solved to the satisfaction of all. With good smooth roads between the cities, the towns, villages, and open country could be brought into intimate association, exchange could be rapid and economical, and the intermediate charges that now add to the first cost from the moment an article is started upon its travels until it reaches the ultimate consumer could be eliminated. The original investment for smooth roadways, interurban and suburban, would be large, but it would pay dividends. Meanwhile the railroads would be at greater liberty to develop their facilities for the handling of heavy freight, and in the long run they would be gainers rather than losers by relief of the congestion now caused by the handling of short-haul business."

Cutting of Street Pavement With Pneumatic Machines

By A. S. E. BEALL

Perhaps no other problem of late years has caused companies operating in cities more expense, delay, and thought, than that of cutting street pavement, for the opening of trenches in the laying of wires for power, telephone, telegraph, and water, gas, sewer, and other pipes underground. Through the efforts of municipal engineers to get the most durable pavement, and the use of first-class rock, cement, and sand, together with the rigid specifications for the laying of asphalt and concrete, the necessity has arisen for some more economical means of cutting pavement than the old pick and shovel method.

Several plans have been tried. Chipping hammers, saws, and other instruments have been introduced, but, with few exceptions, they have not proved successful where time and economy were to be considered.

The Los Angeles Railway Co., wishing to experiment in this particular work, supplied a truck equipped by the Rix Compressed Air & Drill Co. with a gasoline engine and compressor, and by the Hardsocg Wonder Drill Co. with a pneumatic machine. Following a number of trials with different cutting devices on the asphalt and concrete, a chisel tool 4 in. wide, and gads of 1¼ in. steel, 18 in. long, with shanks on each to fit the machines, were used, and a demonstration was made on Vermont avenue and Washington streets, Los Angeles, April 25, in the presence of city engineers and representatives of the gas, telephone, cold storage, light, and power companies. The pavement cut, according to the city engineers, was laid under the latest specifications, and consequently the following figures can be taken as a fair criterion. The work was done under the supervision of P. B. Harris, superintendent of maintenance and construction for the Los Angeles Railway Company.

In removing grouting or pavement laid under older specifications, the minimum figures of actual cost, with hand labor, per lineal foot of trench was 17c. In removing pavement laid under the latest specifications and consisting of 5 in. hydraulic concrete, 1 in. asphalt binder, and 2 in. asphalt wearing surface, the actual cost per lineal foot of trench (hand labor) was 20c. These

Generated on 2024-09-29 23:42 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

figures are based on a trench 18 in. wide. In the trials mentioned the results were as below:

One No. 37 Hardsocg machine cut asphalt, 46-ft. trench per hour, with two men to the machine, at 15c. per hour each; cost per foot	$0.006
One No. 37 Hardsocg machine cut concrete, 45-ft. trench per hour, with three men at 15c. per hour each; cost per foot	0.01
Plant to operate three No. 37 machines	$1,600
Three No. 37 machines	225
Total	$1,825
Interest on the investment at 6%; depreciation 10%—$292 per annum, allowing 300 working days in the year, 97c. per day, at 8 hours per day, 12c. per hour; average execution of machines 45.5 ft. per hour:	
Investment, per hour	$0.12
Engineer, per hour	0.30
Fuel and lubrication	0.35
Total operating expense, per hour	$0.77
Average execution for one machine, 45.5 ft. per hour, cost of operating plant divided by three (number of machines working), cost per lineal foot of trench	$0.0056
Total cost per lineal foot of trench	$0.0216

It was noticeable that several improvements could be made to benefit the operating materially. For instance, the men used for this work were Mexicans from the track gang. They were pick and shovel men only; better labor would give better results. A slight rearrangement could be made that would facilitate the work by utilizing the weight of the men, which would make the work very light and assist the machine materially. When the work was being finished, a run was made with the asphalt cutters in concrete, instead of using the gads, and it was found that they worked much faster and better. No doubt a number of such improvements could be made that would expedite the work and so lower the cost.

Personal

Myron H. Peck has opened offices in the Hearst building, San Francisco.

George Watkins Evans, of Seattle, has gone to the Ground Hog coalfield in northern British Columbia on professional business.

David Dorward, Jr., has resigned his place as mechanical engineer for the Union Oil Co. to accept a similar position with the General Petroleum Company.

M. M. O'Shaughnessy, W. R. Eckart, and Howard C. Holmes were selected by the Mayor to report on the condition of the Twin Peaks reservoir, at San Francisco.

George W. Elliott, of Boston, Charles H. Hodgkinson, of the Edison Electric Illuminating Co. of Boston, and Edward C. Brown, of Chicago, were in San Francisco on the way to attend the Seattle convention of the International Electric Light Association.

Commercial Paragraphs

The Association of Western Portland Cement Manufacturers, Rialto building, San Francisco, has for gratuitous distribution copies of a speech made by L. W. Page, director of Office of Goods Roads of the U. S. Department of Agriculture, as well as those of E. N. Hines, commissioner of roads of Wayne county, Michigan, and J. S. McCullough of Fond du Lac, Wisconsin, all treating of the advantages of using portland cement concrete in permanent roadways.

Catalogues Received

Link-Belt Company, Chicago. Book No. 121, 'Ewart Friction Clutch.' 18 pages. Illustrated. 6 by 9 inches. Also booklet, 'Link-Belt Locomotive Cranes.' 32 pages. Illustrated. 9 by 6 inches.

Generated on 2024-09-29 23:43 GMT / https://hdl.handle.net/2027/uiug.30112007837674
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN